ADDIS ABABA UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT MANAGEMENT

The Challenges of Sewerage and Drainages Maintenance Management System in Addis Ababa city Administration the Case of *Kirkos* Sub City

A Thesis Submitted to Department of Public Administration and Development Management

By:

Nebiyeleul Mulugeta Mersha

Advisor:

Filmon Hadaro (Ph.D)

Aug, 2017

Addis Ababa

ADDIS ABABA UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT MANAGEMENT

The Challenges of Sewerage and Drainages Maintenance Management System in Addis Ababa city Administration the Case of *Kirkos* Sub City

A study by

Nebiyeleul Mulugeta Mersha

_____	_____	_____
Adviser	signature	Date
_____	_____	_____
Examiner	signature	Date
_____	_____	_____
Examiner	signature	Date

LETTER OF CERTIFICATE

This is to certify that, NEBIYELEUL MULUGETA, has Carried out his research work in titled “The Challenges of Sewerage and Drainage Maintenance Management in Addis Ababa City Administration in The Case of *Kirkos* Sub City”, under my supervision. This work is original in nature and it is suitable for submission for the award of Master Degree in Public Management and policy.

Filmon Hadaro (Ph.D)

Advisor

STATEMENT OF DECLARATION

I declare that the research work entitled, “The Challenges of Sewerage and Drainage Maintenance Management in Addis Ababa City Administration in The Case of *Kirkos* Sub City”, is my original work. It has not been presented in and out of Addis Ababa University. All source of material used for the research have been duly acknowledge.

*Nebiyeleul Mulugeta Mersha*_____

(The researcher)

Acknowledgment

Due to the nonexistence of studied researches in utilizing drainage maintenance; I hearty extend my gratitude to all those cooperated with patency so as to conduct my research as much my capacity able to do.

I would like to extend my special thanks to *Dr.Filmon Hadaro* my advisor, who has given me his encourage and guidance Furthermore, I hearty extend my gratitude to Addis Ababa City Roads Authority Employees, various organs of the sub city as well as residents of the sub city or the information they provided for the purpose of this research.

I thank him who *Alemayehu (Chere)* who has been many young people get rid of from their Chat and Alcohol addiction in establishing sport center *Yelegehar Fere* Body Building House (GYM) *Kirkos* sub city *woreda* 10 at the back side of *Legehar* around *kolo tera* Within the Sub city that is considered as pioneer from 1968. I am also indebted to thank *TF* World Taekwondo Club *Kirkos* Sub city *woreda* 9 at the back side of *Meskel* Square.

At last but not least, I remember my mother.

Table of Contents

Contents **Pages**

List of Tables

List of abbreviation

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Bipheny an Organic Chlorine Compound
PGEs	Platinum Group Elements
UNCHS	United Nations Centre for Human Settlement
Woreda	Third-Level Administrative Divisions

Abstract

The drainage system that supported with adequate information, program and having sustainability, in adding psychological ownership of the community in line with utilizing and caring the same which allow to prevent traffic accident as well as preventing damage over health of the community and property of government thereby the community may move freely with desired speed and make them competent.

Whereas, this research for drainage after construction that over city administration of Addis Ababa *Kirkos* sub city towards post construction stage with the management as per that challenging conditions in maintaining and utilizing on side of the community and hence the information collected for research include mixed quantitative and qualitative data and the research design is also exploratory.

Result of the research shows that reason that make difficult for maintenance, beyond the absence of system governing with monitoring and maintenance that is modern equipped with information and substantiated with program; the city administration of Addis Ababa executed organs do not perform activities in integrated and helping each other, rather they explicitly perform the same.

The problems creating on side of the residents have always commit with negligence and thus that make difficult to monitoring is due to the psychological ownership do not have created within such residents.

The *woreda* shall record adequate information for drainage system which located within the same area, in following up maintenance program, in convincing residents and initiating the youth that ready for change for collaboration as well as integrating them in which when some mark has shown for drainage that may easily repairing should be maintained with voluntary satisfaction and with minimum cost before creating huge damage.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Drainage is the act of draining. Drainage is a channel or pipes a trench or a ditch through which water or other liquid flows off. Road is public asset and no road is constructed without drainage because water damages roads that are constructed without drainage system. (Addis Ababa City Road Authority, 2015, p.9)

Proper drainage is critical to control water flows on the roads poor drainage maintenance may enhance minor damages to major roads breaks and damage to structures in the long run poor water control lead to the rapid deterioration of the road this will lead to higher maintenance demands cost and in the worst cases result in serious damage which may obstruct the passage of traffic. Good drainage system reduces road maintenance cost. By the same token an efficient drainage system is increases the life of the road. It allows water to flow off and away from the road as quickly as possible as well as including the flow of liquid wastes Furthermore. It helps to prevent flooding of the road and bonding on the road surface, it protects the bearing capacity of the pavement and the sub grade material. In addition to this proper road drainage avoids erosion from the side slopes. (Dr. R. R.Singh et.al. 2014, p.19)

Studies show that poor drainage systems create a number of serious problems. Smelling pools on the side of roads affect public health and initiate transmissible (water-born) diseases. (World Health Organization, 1991, p.3) It may also create traffic crowdedness and people lose a lot of time in traffic jam and increase the travel time. This reduce productivity of a labour in the community as well as causes risk to traffic safety a wet road surfaces reduce friction and may leads to longer breaking distance as well as accidents This accordingly may increase traffic accident like vehicles to vehicles and vehicles against pedestrians causing

damage to property death and permanently disable to peoples and animals across the road and the road sides.

The most common causes of road drainage problem were found related to improper road geometry, insufficient capacity of drainage structures, poor construction, and lack of proper maintenance. Magdi, (2016) (Tiza, Michael Toryila, Iorver et.al. 2016, p.123)

As mentioned above, poor drainage problem is caused mainly by design and construction works, Although studies conducted in the area have been only few in number and only conducted by civil and environmental engineering professionals, they identified details of problems associated to design and construction works and come up with recommendations for raising awareness among residents;(*Tillahun Tessema*, 2016) (*Sewagegn Terefe*, 2016) and still there has been is no study conducted on post construction where poor drainage problems are created. Poor drainage problems after construction works may also be caused due to utilization and maintenance on the part of the community, and there is a gap in studies aimed at creating a sense of ownership in protection of public assets. Also persuading the community, coordinating and mobilizing educated youths who are close to change in close collaboration with executive bodies. This study attaches due attention to fill this gap. Moreover, linking design completed drainage works constructed with the community at all levels' starting from design to utilization without any gap is essential to deliver appropriate services expected of us. This study is thus aimed at assessing the management aspect in post construction stage. The design and the construction stage will be left to the engineers. Thus, study was alleviating the burden of Addis Ababa City Road Authority, while also protecting poor communities from damages associated to poor drainage system. And reducing cost to government.

1.2. Statement of the Problem

The existing situation of drainage in the city and poor utilization of the people, coupled with lack of public awareness in the area, is causing damage to public health and property of its dwellers while also compelling significant government budget allocation.

This could be illustrated in a study showing in addition to persons who are disposing solid waste in drainage manholes after construction, 601 persons linked sewerage with drainage, which was proved by evidence and appropriate legal action has been taken on perpetrators of such act. (The Office of Code Enforcement Service, 2017, p.6) Moreover, legal action has been often taken by court on persons who committed unlawful acts of stealing drainage manhole steel covers. (Addis Ababa City Road Authority, 2016, p.144)

As a result, the practice of taking out water from poor, blocked drainage collecting it on road surface is causing moisture and eventual demolition of the road, but also causing and increasing road traffic accident by reducing friction. In 2015, road traffic accidents 73 people were killed, 144 persons sustained severe physical disablement, and 36 persons sustained light physical disablement and damage to 1,105 properties, which was attributed to formation of moisture on the surface of the road. (Addis Ababa Police Commission, 2016)

On the other hand the researcher observed that people with disability or special need as well as drunk sustained various levels of injures from missing manhole covers along the roads. In the *Kirkos* sub city some manholes and drain holes are not covered securely this types of manhole and drain cover accidents still happen and can causes injuries. It's difficult to get the particular or detail statistics of injured in uncovered manhole because Addis Ababa police commission statistics shows except traffic accident other different accidents were prepared generally so the researcher could not show the number of accidents in uncovered manholes and drain however, the researcher observed that pedestrians were falling into missing manhole covers. Everyone has the right to a

standard of living adequate for the health and well-being of himself and his family including food, clothing, housing and medical care and necessary social services, and the right of security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control. (Universal Declaration of Human Right, Article 25, 1 p.5) and all persons have the right to a clean and healthy environment (Ethiopian Constitution Article 44, p.23) Therefore this study is important from the angel of people's right.

Similarly, the researcher was inspired in road and road related costs, because the government budget affect highly. In 2016 budget year in six months Addis Ababa City Road Authority spend 1, 982 328 112 birr for road and road related works (Addis Ababa City Road Authority, 2016, p.2) In the same way vehicles spear part and fuel consumption in general operating cost increased because of poor drainage systems.

Studies conducted in the area have been only few in numbers and only conducted by civil and environmental engineering professionals, on poor design and construction, (*Tillahun Tessema*, 2016) (*Sewagegn Terefe*, 2016) no study conducted on post construction where poor drainage problems are created in utilization and maintenance on the part of the community or the society.

This research focuses on the various challenges of maintenance management system *Kirkos* sub city the study specifically enquired the following specific questions.

- What is utilization problems observed in the community?
- What kinds of drainage maintenance problems are observed in the road of *Kirkos* sub city?
- What are the problems existing in the community?
- What are the causes of the drainage problem in the roads of Kirkos sub city?
- What are the challenges of the current drainage and maintenance management systems in *Kirkos* sub city?

- In what ways is drainage problem managed efficiently and effectively in sub cities*?*

1.3. Objective of the Study

1.3.1. The General Objective

The main objective of this study was to assess the challenges of efficient and effective sewerage drainage and management systems in Addis Ababa Administration, focusing on the evidence from the selected roads in *Kirkos* sub city.

1.3.2. The Specific Objective

- Explore is the relationship of the community with the Administrative organs and Executive bodies of the sub city look like?
- Explore the kind of drainage problems as observed in the road of *Kirkos* sub city.
- Explore the causes of the drainage problems in the roads of *Kirkos* sub city.
- Explore the challenges of the current drainage and maintenance management system in *Kirkos* sub city.
- Explore the felling of psychological owner ship in drainage utilities.

1.4. Significance of the Study

This study is significant, Road is a huge public asset which provides large benefits to the society it also plays important role in maximize economic and social benefits. Poor road infrastructure increase transport cost likewise road is a key constraint for industrial development out of factors the damage roads water (poor drainage systems)a key one poor drainage system seriously affect the flow of traffic public road infrastructure in Addis Ababa manifests problem related to water waste and in appropriate maintenance. This study contribute by providing information about the drainage maintenance problems in the Roads of *Kirkos*

Sub City describe the causes relate to efficient and effective system of drainage and maintenance system management.

1.5. Scope of the Study

For geographical location the researcher select *Kirkos* Sub City from other Sub Cities. The longest poor surface drainage and dozen poor manholes were found in this Sub City. The drainage grades indicate that in *Kirkos* Sub City 72,002 meter surface drainage and 3,600 manholes were poor or it has critical drainage problem. (Addis Ababa City Road Authority, 2016)

In the same way proper Road includes pedestrians walk ways, pedestrians fencing, proper drainages, traffic signs, traffic lights, traffic lines marking, and street lights. For this research the researcher focus only in poor drainages in *Kirkos* sub city in selected roads. (See Appendix, p.113)

The scope of the study discusses the maintenance and management aspect of the drainage system. Therefore this study is limited to presenting the challenges of sewerage and drainage maintenance and management system in Addis Ababa city Administration in the case of *Kirkos* sub city in selected road for the current year 2016.

Kirkos sub-city is located at the centre of Addis Ababa. The sub city has eleven districts or *woreda's.* It includes *Anbasader, Kazanchiz,* S/t Urael church *Wolo Sefer, Gotera, Bulgaria mazoria Mexico* areas. Addis Ababa stadium and *Meskel* square are located in this sub-city. The sub-city hosts of the African continent offices such as The Office for Organization for African Union (OAU) and the United Nations Economic Commission for Africa (ECA). Sheraton Addis, Hilton, *Ghione*, and dozen hotels found in this sub city schools and health center, church, mosques are found in this sub city *Kirkos* sub-city is characterized by a combination of modern buildings and old residential settlements. The residents are highly differentiated in income.

1.6. Limitation of the Study

Nonexistence of studied researches in utilizing drainage maintenance and availability of sufficient current literature on the topic considered as limitation of this study.

1.7. Organization of the Paper

The research was containing five chapters. In the first chapter the research would focus on the introduction part which gives the base for the whole paper. In the second chapter the research would focus on the drainage issues that are theoretical related literature review and empirical review to the topic of the paper. The third chapter is about research methodology the fourth chapter data results and analysis chapter five is conclusions and recommendation.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

This chapter reviews both the theories and empirical studies on drainage and drainage maintenance management system. In addition to this the chapter discusses the theoretical and conceptual framework of the researcher used it.

2.1. Theoretical Reviews

The theoretical review discusses the historical back ground of drainage system urban drainage, the effect of bad drainage on health, the effect of poor drainage on road, the effect of poor drainage on environment, the effect of bad drainage on production and economy it also discusses in brief the maintenance management system and the importance of community participation in drainage maintenance.

2.1.1. Definitions and History of the Art of Drainage

The art of removing superfluous water from land, must be as ancient as the art of cultivation and form the time when Noha and his family anxiously watched the subsiding of the waters into their appropriate channel to the present, men must have felt the ill effect of too much water and adopted means more or less effective to remove it (Henry Flagg French, 2007, p.39)

(According to Webster's Dictionary, 1993, p. 685) Drainage is the act or method of draining. Drain is a channel or pipes a trench or a ditch through which water or other liquid flows off.

When the population of the world small and thinly distributed the people tended to be nomadic, so there is no great accumulation of the waste products of human and their activates. However, as human began to congregate in fixed settlements the effect of the accumulation of waste products on the health of the community soon became evident and measure, however primitive, had to be taken to alleviate the problem. An early example this is given in the book of Deuteronomy.

The tribes of Israel, After the Exodus from Egypt, had been leading a nomadic existence for several years in the Sinai desert, but they finally settled, for a considerable time, at the foot of Mount Sinai. The problem of disposing of the accumulation of waste matter in the settled camp then arose and the instructions to over comes this problem, are recorded in Deuteronomy chapter 23, verses 12-13, ″thou shalt have a place also without camp, whither thou shalt go forth abroad; and shalt have a paddle up on thy weapon; and it shall be, when thou wilt ease thyself abroad thou shalt dig therewith, and shalt turn back and cover that which cometh from thee.”(Authorized Bible, 1611) (Dr.Tim Evans. & N. Orman, 2013, p.8)

Archeological excavations of many of the ancient cities have revealed evidence of sewers in these cities. The following examples provide an over view of drainage system in four cities of the ancient world Mohenjo_Daro was an early city located in the south of what is now Pakistan, in the west bank of the Indus River. It was built between four and five thousand years ago, and lasted until around 1,700 BC. The city had at least 35, 000 residents and archeological excavations reveled that most houses has small bath rooms and the streets contained backed brick drains. At about the same time (1,700) the Minoan civilization in Crete built the palace at Knossos which has been found to have an elaborate water supply and drainage system, including a flushing water closet, to deal with waste water and storm water as well as to supply fresh water. (Dr. Tim Evans. & N.Orman, 2013, p.9)

The ancient city of the Baghdad, which was in its prime around 800 AD, had a population of some two million. “The city was divided into blocks or quarters, each under the control of an overseer or supervisor, who looked after the cleanliness, and sanitation and the comfort of the inhabitants. The water exits, both on the north and the south, were like the city gates, guarded night and day by relays of soldiers stationed on the watchtowers on both sides of the river. Every household was plentifully supplied with water at all seasons by the numerous aqueducts which intersected the town; and the street gardens and

parks were regularly swept and watered, no refuse was allowed to remain within the walls.'' (Davis 1913) sections of Romans drainage pipes are still functioning in some towns and cities in Britain and across the former Romans Empire. The more than 2000 years old ceramic drainage pipes excavated at the Greco-Roman city of Ephesus (population 500 000 in 100 AD) It was the most important city of the eastern Mediterranean and the second city of the Roman Empire. Finally, in this quick look at the early development of urban drainage, mention must be made of the city of Rome where a sewer, the Cloaca Maxima, constructed around 600 BC is still in use as a part of the sewer system of the modern city. (Dr. Tim Evans. & N.Orman, 2013, p.10)

Several ancient civilizations showed great care when constructing urban drainage systems, combining the objectives of collecting rainwater, preventing nuisance flooding, and conveying wastes. During the Roman Empire Age, significant advances were introduced in urban drainage systems. Concerns on urban flooding mitigation and low lands drainage were very important to the city of Rome, which arose among the hills of Lazio region, on the margins of Tiber River. To meet urban drainage needs, a complex network of open channels and underground pipes were constructed. This system was also used to convey people's waste from their living areas (Burian and Edwards, 2002). (Marcelo Gomes Miguez et.al. 2012, p.22)

During the middle Ages, urban centers suffered a great decay and people tended to live in communities sparsely established in rural areas, near rivers, with minor concerns about urban drainage. Sanitation practices have deteriorated after the decline of the Roman Empire and surface drains and streets were used indiscriminately as the only means of disposal and conveyance of all wastewaters (Chocat et.al. 2001). Later, when cities started to grow significantly again, in the Industrial Era, urban drainage found itself regretted to a second plane. The industrial city grew with very few guidelines. The Liberalism influenced urban growth and there was a certain lack of control on the public perspective for city development (Benevolo, 2001). Sanitation, then, became a

great problem and inadequate waste disposal led to several sort of diseases and deterioration of public health. The role of urban drainage became very important in helping to solve this problem and, more than often, it was important to fast collect, conduct and dispose securely storm water and wastewater. Focus was driven to improve conveyance and this was the main goal of urban drainage, until some decades ago. However, considering the fast urban growth of the last two centuries, and the fact that the world population profile is changing from rural to urban, it became hard to simply look at urban drainage and propose channel corrections, rectifications and other similar sort of interventions. Canalization could not answer for all urban flood problems and, in fact, this isolated action, in a local approach, was responsible for transferring problems more than solving them. The increasing flood problems that the cities were forced to face showed the unsustainable of the traditional urban drainage conception and new solutions started to be researched. (Marcelo Gomes Miguez et.al. 2012, p.22)

2.1.2. Methods of Drainage Systems

(Henry Flagg French, 2007, p.186) Stated that there are various method of drainage Open ditches, slope of banks brush drains, ridge and furrow Plug drainage mole drainage mole plow. Wedge and shoulder Drains. Peat tiles stone drains injured by moles downing's giraffes.

There are many different types of drainage systems with different design features and attributes that can be used to manage flows and treat water quality. Drainage which is needed on the Highways Agency network depends not just on any flood risks and pollution risks identified but the characteristics of the natural water catchment area in which the network is based. The size, shape, gradient and geology of a catchment area are all factors which can influence the type of drainage methods used. (Dr. R. R.Singh et.al. 2014, p.20)

The principle types of drainage systems are: open drain, piped (positive) Drain, French Drain. The type of road drainage which is selected for a particular road will depend on such factors as to whether it is a rural or an urban road, or if it is in

cut or fill and also on groundwater conditions (Report RC. 50, 1971). (Victor K. Rono, 2014, p.11)

Open drains are used to carry away surface water and can also pick up some subsoil water (depending on depth). Open drains facilitate the early visual detection of blockages but their use may be restricted by the lack of roadside space, safety considerations and the risk that they may be closed in by agricultural machinery (Victor K. Rono, 2014, p.11)

A “closed” drainage system is one in which the roadway curbs and gutters act as the\ storm water collector and direct the flow to curb inlets, gutter inlets or a combination of both. The inlets feed the storm runoff into underground catch basins and manholes that are connected to the storm sewer lines. (M. Coughlan & George W. Greenwood, 2007, p.53)

Piped drainage systems are essential in urban areas and are also used in rural areas where space is limited. Piped systems can be sealed or open-jointed. The normal practice is to use sealed systems in urban areas and open-jointed systems in rural areas. Piped systems with gullies require regular maintenance and while in many instances these systems are cleaned annually the data received suggests that the frequency of maintenance is generally considered inadequate (Mr. Ger Finn et.al, 2004, p.17)

A piped positive drain is normally associated with an urban situation and is used in conjunction with gullies and kerbs. It may also be used in some rural embankment situations where it is deemed important that water from the road and hard shoulder should not be allowed to drain onto the embankment. A piped drainage system with gullies requires regular maintenance. (Victor K. Rono, 2014, p.12)

A French drain is the most commonly used system on newly constructed roads in rural areas. Open jointed pipes are laid in a trench which is backfilled with a porous material. French drains are useful methods of providing both surface

water and sub grade drainage where space is limited. (Victor K. Rono, 2014, p. 12)

Surface drainage the surface water is to be collected and then disposed of. The water on the surface is first collected in longitudinal drains, generally in side drains and then the water is disposed of at the nearest stream, valley or water course. For the preparation of surface drainage, we should keep in mind various things like (Dr. R. R.Singh et.al. 2014, p.20)

2.1.3. Urban Drainage

As cities started to grow, especially after the Industrial Era, urbanization problems became greater and urban floods increased in magnitude and frequency. The traditional approach for the drainage systems, which were important as a sanitation measure in the first times of the city's development, conveying storm waters and wastewaters, turned unsustainable. Flow generation increased and end-of-pipe solutions tended to just transfer problems to downstream. In this context, in the last decades, several approaches were developed, in order to better equate flow patterns in space and time. However, not only the hydraulics aspects are important. Technical measures do not stand alone. The water in the city needs to be considered in an integrated way and sustainable solutions for drainage systems have to account for urban revitalization and river rehabilitation, better quality of communities' life, participatory processes and institutional arrangements to allow the acceptance, support and continuity of these proposed solutions. (Marcelo Gomes Miguez et.al. 2012, p.22)

Traditional practices of urban drainage design are based on canalization works in order to adapt the system to the generated and concentrated flows. This approach equates the undesirable consequences of the flooding process, which are the greater and faster discharges produced by the built environment. The urban drainage system comprises two main subsystems: micro-drainage and macro drainage. The micro-drainage system is essentially defined by the layout

of the streets in urban areas, acting in collecting rainfall from urban surfaces. The macro-drainage is intended to receive and provide the final discharge of the surface runoff brought by the micro-drainage net. Macro-drainage corresponds to the main drainage network, consisting of rivers and complementary works, such as artificial canals, storm drains, dikes and other constructed structures. In general terms, the urban drainage system design comprises the following steps: subdivision of the area into sub-catchments; design of the network integrating urban patterns and natural flows; definition of the design rainfall, considering a certain time of recurrence and a critical time of duration, associated with the concentration time of each sub-catchment considered; step by step calculation of design discharges for each drainage network reach through the Rational Method or another convenient hydrological method; hydraulic design of each drainage network reach. (Marcelo Gomes Miguez et.al. 2012, p.27)

In urban roads because of the limitation of land width and also due to the presence of footpath, diving island and other road facilities, it is necessary to provide underground longitudinal drains. Water drained from the pavement surface can be carried forward in the longitudinal direction between the curb and the pavement for short distances which may be collected in catch pits at suitable intervals and lead through underground pipes. Drainage of surface water is all the more important in hill roads. In hill roads disposal of water is also very important. Certain maintenance problems may arise due to faulty hill road construction. (Dr. R. R.Singh et.al. 2014, p.20)

Highway drainage is the process of removing and controlling excess surface and sub-surface water within the right way. This includes interception and diversion of water from the road surface and sub-grade. The installation of suitable surface and sub-surface drainage system is an essential part of highway design and construction. (Dr. R. R.Singh et.al. 2014, p.19)

The traditional approach for drainage system design is being supplemented or replaced by newer concepts that seek for systemic solutions, with distributed actions over the catchment, trying to recover flow patterns similar to those that

happened prior to urbanization. Storage and infiltration measures are considered together in integrated layout solutions. Moreover, these new trends add concerns of water quality control, as well as enhance rainwater as a resource to be exploited in an integrated approach for sustainable management of urban storm waters. Besides, the possibility of combining flood control measures with urban landscape interventions, capable to add value to urban spaces, with multiple functions, is becoming an interesting option from the point of view of revitalizing degraded areas, as well as optimizing the available resources for public investments. The vision of integrating urban drainage projects with urban development plans and land use and occupation management, provides a better temporal and spatial range of action for flood control projects, as it seeks to intervene not on the consequence of heavy rains, but on the inundation causes. The changing to a point of view of more sustainable solutions on urban drainage requires a commitment with the future consequences concerning the decisions taken today; so solutions must be flexible enough to allow possible modifications and adaptations in the course of urban development (Canholi, 2005). (Marcelo Gomes Miguez et.al. 2012, p.29)

In urban roads because of the limitation of land width and also due to the presence of footpath, diving island and other road facilities, it is necessary to provide underground longitudinal drains. Water drained from the pavement surface can be carried forward in the longitudinal direction between the curb and the pavement for short distances which may be collected in catch pits at suitable intervals and lead through underground pipes. Drainage of surface water is all the more important in hill roads. In hill roads disposal of water is also very important. Certain maintenance problems may arise due to faulty hill road construction. (Dr. R. R.Singh et.al. 2014, p.20)

2.1.4. Necessity of Highway Drainage

Highway drainage is important from various viewpoints: Excess moisture in soil sub-grade causes instability under the road surface. The pavement may fail due to sub-grade failure. In some clayey soil variation in moisture content causes

considerable variation in volume of sub-grade. This sometimes contributes to pavement failure. The waves and corrugations formed in case of flexible pavements also play an important role in pavement failure. Sustained contact of water with bituminous pavements causes failure due stripping bitumen from the aggregates like loosening of some of the bituminous pavement layer and formation of pot holes. The prime cause of failures in rigid pavements by mud pumping is due to the presence of water in fine sub-grade soil. Excess water on shoulders and pavement edge causes considerable damage. Excess moisture causes increase in weight and thus increase in stress and simultaneous reduction in strength in soil mass. This is one of the main reasons of failure of earth slope and embankment foundations. In place where freezing temperatures are prevalent in winter, the presence of water in sub-grade and a continuous supply of water from the ground water can cause considerable damage to the pavement due to in frost action. Erosion of soil from top of un-surface roads and slopes of embankment, cut and hill side is also due to surface water. Failure due to hydraulic pressure and failure due to binder stripping can be avoided with the help of proper drainage on roads. (Dr. R. R.Singh et.al. 2014, p.19)

Highway drainage system is importance for removing water from the road surface, preventing ingress of water into the pavement, passing water across the road, either under or over and preventing scour or washout of the pavement, shoulder, batter slopes, water courses and drainage structures. He identified types of drainage on the highway to include curb and gullies, surface water channel, combined filter drain (French drain), over-the-edge drainage, drainage channel locks, combined curb and drainage units, linear drainage channels, fin and narrow filter drain (sub-surface drainage) and edge drainage for porous asphalt. (Muhammad, 2014).(Tiza, Michael Toryila, Iorver et.al. 2016, p.219)

In a research on drainage on roads by Singh, Navpreet and Nitin (2014), a well-designed and well maintained road drainage is important in order to: minimize the environmental impact of road runoff on the receiving water environment, ensure the speedy removal of surface water to enhance safety and minimize disruption to road users and to maximize the longevity of the road surface and

associated infrastructures. Water in the pavement system can lead to moisture damage, modulus reduction and loss of strength. In order to prevent such damages to the pavement, it is essential to provide proper drainage to the roads. They maintained that the presence of water in a highway layer reduces the bearing capacity of the road, and in doing so it also reduces the structure's lifetime. Highway drainage is used to clear surface water from the highway. Roads need to be well drained to stop flooding; even surface water can cause problems with ice in the winter. Water left standing on roads can also cause maintenance problems, as it can soften the ground under a road making the road surface break up. (Tiza, Michael Toryila, Iorver et.al. 2016, p.220)

Drainage is a must component in the road construction. In lay world language we know that tarmac and water are never “best friends.” For this reason in most designs of the road, the first thing to be put in place is drainage system. The presence of water in the pavement layer will tend to reduce the bearing capacity of the road and thereby its lifetime. It is required that the surface water from carriage ways and the shoulders should be efficiently drained off without allowing it to the subgrade of the road (Mwangi, 2013).(Victor K. Rono, 2014, p.1)

Highway drainage should fulfill the following objectives: prevent flooding, ponding and seepage, and keep the carriageway, cycle way and footway as free of standing water as possible; ensure surface water falling on the highway enters the drainage system or natural watercourse as speedily as possible; keep the underlying road structure as dry as possible; prevent injury or damage caused by hazardous surface water; prevent highway surface water flooding adjacent properties and prevent blockages in associated highway drainage systems with consequential flooding. Bath & North East Somerset Council (2016). (Tiza, Michael Toryila, Iorver et.al. 2016, p.120)

Table 1: Effects of Water on The Road Surface

Positive effects of water on the road	**Negative effects of water on road**
Establishing and maintaining vegetation for erosion control Working gravel road surfaces Providing dust control; and Cleansing the road and pavement surface	Softening and reducing the load carrying ability of subgrades and shoulders; Increasing the disintegration of pavements and gravel surfaces; Eroding roadside surfaces; Depositing sediment and debris in ditches, pipes, catch basins and waterways; and Contributing to frost heaves and spring break-up. Creating driving hazards for motorists. Damaging adjacent property.

(Victor K. Rono, 2014, p.27)

(Dr. R. R.Singh et.al, 2014, p. 21) in the conclusion seeing the above properties of drainage and keeping in view the necessity of drainage at surface as well as sub-surface level, drainage plays an important role in highway engineering. As drainage helps in avoiding various types of failures as may be caused by stagnant water on the road surface or its seepage beneath the pavement, it is important to provide drainage facility while construction of roads. Thus to increase the life of the road and to reduce the maintenance cost drainage of roads must be properly provided. Considering the above factors, this paper has been attempted in lieu of highway engineering.

The main functions of a road drainage system are: To prevent flooding of the road and ponding on the road surface to protect the bearing capacity of the pavement and the sub grade material to avoid the erosion of side slopes (Mr. Ger Finn et.al. 2004, p.5)

2.1.5. Effects of Poor Drainage

2.1.5.1. Effects of Bad Drainage on Roads

(PatilAbhijit, & PatilJalindar, 2011, p.3) in the conclusion the effect of poor drainage condition on road is very adverse. It causes the failure of road in different ways. Proper drainage system provided to the road increases the life of roads. But the improper drainage system causes the failure of the road at its early edge.

From the review, it has been concluded that poor drainage facilities on highway structures has many devastating effects on the economy of users, as both functional and structural failures due to poor drainage leads to increase in travel time, thus reducing productivity of a community or nation, it leads to sicknesses such as Malaria fever due to breeding of mosquitoes in stagnant water around poorly drained pavements in residential areas, there is increased number of accidents thus leading to the death of many. etc. (Tiza, Michael Toryila, Iorver et.al. 2016, p.124) But the improper drainage system causes the failure of the road at its early edge. Therefore effective engineering practices should be considered necessary during design, construction and management of roads and drainage channels. (Tiza, Michael Toryila, Iorver et.al. 2016, p.118)

Studies show that the effects of bad drainage on roads with precision on some roads in India. It was found that increase in moisture content increases the chances of road failure before the stipulated or expected design life. (Patil and Jalinder (2011). (Tiza, Michael Toryila, Iorver et.al. 2016, p.122)

Water logging: When water from any source finds no path to escape or drain out and create a hazardous situation is known as water logging. Excessive rainfall,

inadequate drainage sections, conventional drainage system with low capacity and gravity, natural siltation, absence of inlets and outlets, indefinite drainage outlets, lack of proper maintenance of existing drainage system, and over and above disposal of solid waste into the drains and drainage paths are accounted for the prime causes of water logging. From the observation of road network in it many roads are affected by water logging. This is cause due to absence of any drainage system, improper maintenance of drainage facilities etc. (Mr.Dipanjan Mukherjee, 2014, p.50)

The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime. Some remedial measures should be suggested to eliminate all the problems. Maintenance work should be done regularly by the authority. The people should be aware about the traffic rules and use the road properly (Mr.Dipanjan Mukherjee, 2014, p.50)

2.1.5.2. Effects of Bad Drainage on Health

Areas experiencing poor drainages like the areas under study allow runoff from these areas to have an interaction with black water from exposed or overflowing septic tank systems causing outbreak of water-borne related diseases and also, infiltration and percolation of this polluted water into the ground water will cause contamination. This is a conduit for gastro-intestinal diseases such as constipation, anal disorders, and structural disorders amongst others. To curb these hazards, proper cleaning of channels should be done on a regular basis and not only on sanitation days to reduce the habitation of pathogens responsible for these diseases. Also, more refuse dumps (collection points) be provided in this areas understudy and be visited by the agencies responsible on a regular basis to help reduce epidemics. (David O. Olukanni et.al. 2014, p.103)

First in public health importance are the many “faecal-oral” infections acquired by consumption of contaminated food and drink. The microscopic pathogens that cause them are found in the excreta of infected people or animals. Surface water becomes contaminated with these pathogens from sources such as blocked

sewers and overflowing septic tanks, and often from defecation in the open by livestock and by people who have no toilet. This contaminated surface water can then infect people in many ways. It can contaminate their hands, their utensils or their drinking-water supply Children are particularly exposed to infection when playing or bathing in surface water (World Health Organization, 1991, p.2)

Spreading pathogens around communities and increasing risks to health from various waterborne diseases. Infiltration of polluted water into low-pressure water supply systems can contaminate drinking water and is frequently a source of gastrointestinal disorders. Wet soils in poorly drained areas, which become faecally contaminated due to poor sanitation, also provide ideal conditions for the eggs of parasitic worms, such as roundworm and hookworm, which can cause debilitating intestinal infections Open drainage channels are potential sources of infection and disease especially to children who play in them, and polluted water from drains is often used for agriculture, where water resources are scare. Flooded septic tanks and leach pits, and blocked drains provide breeding sites for *Culex* mosquitoes, which transmit filariasis, a condition that can lead to elephantiasis and its painful swelling of the legs. Alsorelated to drainage conditions are *Aedes* mosquitoes, which transmit yellow fever, dengue and dengue haemorrhagic fever. These mosquitoes often breed in containers which fill with water during rain, such as domestic water storage containers, discarded cans, tyres, plastic bags and coconut shells. *Anopheles* mosquitoes, which transmit malaria, are also a risk in urban areas, and they lay their eggs in still, unpolluted water, for instance in wetlands and on pond surface waters, which are commonly found where drainage is poor (Kolsky, P.1999). (Dr. Jonathan Parkinson, 2003, p.118)

The faecal-oral diseases include the well-known water-related diseases that are often fatal, such as cholera and typhoid fever, but also the many common diarrhoeal diseases that particularly affect young children in developing countries, contributing to malnutrition and death. In fact, these diarrhoeal diseases are often responsible for more child mortality than any other cause of

death. Important measures for their control are an improved water supply and better sanitation, but these are almost impossible to install in areas subject to frequent flooding. (World Health Organization, 1991, p.3)

Drainage of runoff by controlling surface water and water logging and by eliminating unnecessary open water surfaces is an essential and effective tool for reducing and eliminates mosquito breeding sites. Poorly maintained drainage canals can provide potential breeding sites for various mosquito species if they are permanently flooded and aquatic weeds are not cleared. It is important that efforts be well targeted. For instance, a filariasis vector control research project carried out in Pondicherry in India surveyed a range of different breeding sites, such as drains, soakage pits and flooded land, and measured the number of mosquito larvae and pupae. (Dr. Jonathan Parkinson, 2013, p.4)

In countries where schistosomiasis is endemic, poorly drained urban areas present ample opportunities for transmission of the disease. Contamination of standing water with the faeces of infected persons (or, for one form of the disease, with their urine) enables the schistosomes, the microscopic parasites that cause this infection, to reach the small aquatic snails in whose bodies they multiply. From every infected snail, thousands of schistosomes emerge and swim in the water. Local residents become infected when they enter the water and the schistosomes penetrate their skin. (World Health Organization, 1991, p.3)

2.1.5.3. Effects of Bad Drainage on Environment

Well designed and well maintained road drainage is important in order to minimize the environmental impact of road runoff on the receiving water environment. Ensure the speedy removal of surface water to enhance safety and minimize disruption to road users. Maximize the longevity of the road surface and associated infrastructures (Dr. R. R.Singh et.al. 2014, p.20)

Table 2: A Summaries of Urban Storm Water Pollutants and their Environmental Effect is Shown in Table Urban Storm Water Pollutants

CONSTITUENTS	ENVIRONMENTAL EFFECT
Sediments – Total Suspended Solids	Turbidity changes Habitat changes Recreation/aesthetic loss Contaminant transport
Nutrients – Nitrogen, Phosphorus	Algae bloom Eutrophication Recreation/aesthetic loss
Heavy Metals – Copper, Zinc, Lead, Cadmium, Nickel, Chromium	Aquatic toxicity Bioaccumulation
Organic Pollutants – PAHs, PCBs, pesticides	Aquatic toxicity Bioaccumulation
Other Pollutants – PGEs, Pathogens, Oxygen demanding (BOD, COD)	Aquatic toxicity Dissolved oxygen depletion Infections Fish mortality
Thermal Pollution	Dissolved oxygen depletion Habitat changes

(Stefan Ahlman, 2006, p.15)

2.1.5.4. Effects of Bad Drainage on Production and Economy

From the review, it has been concluded that poor drainage facilities on highway structures has many devastating effects on the economy of users, as both functional and structural failures due to poor drainage leads to increase in travel time, thus reducing productivity of a community or nation, it leads to sicknesses such as Malaria fever due to breeding of mosquitoes in stagnant water around poorly drained pavements in residential areas, there is increased number of

accidents thus leading to the death of many. etc. (Tiza, Michael Toryila, Iorver et.al. 2016, p.124)

Poor road conditions and transportation system hinder movement of goods and people in the urban areas. Lack of adequate infrastructure could also be a disincentive to both local and foreign investors in our urban areas. Constraints to productivity at the city level, such as infrastructure deficiencies presented below reduced the productivity of firms and households and this affected the aggregate productivity of the economy (World Bank, 1992)(Austin Otegbulu, 2011,p.3)

Cities have played a key role in the evolution of the global economy. Cities are generators of enormous wealth and act as the powerhouse of the national economy. There is a clear link between the performances of urban areas and the performance of the economy as a whole (Oately, 1998; 3-20). The strength of the nation's economy, the contact point of international economics, the health of our democracy and the vitality of the humanistic endeavours all are dependent on whether the city works (Ciceros cited in Lawless, 1996; 28).(Austin Otegbulu, 2011, p.3)

Transportation plays a major role in economic development both urban and national. It also has a broader role in shaping development and the environment. The interface between transportation investment and economic development has broad ramification that goes beyond the basic purpose of moving goods and people. Transportation facilities are located in a specific place, they provide services to businesses and households within a specific geographic area, and their use is directly related to moving goods and people between two points. It is essential in the operation of a market economy (Eberts, undated). It should be noted that road infrastructure is fundamental to urban transportation, as it provides access to land and determines whether it is ripe for development or not. It is a determinant of where people can live or not live and constitutes a catalyst to urban development).(Austin Otegbulu, 2011, p.3)

The poor performance and mismanagement characterizing most publicity-owned and operated utilities gave the impetus for considering private sector participation. Unsustainable levels of budget deficits and external debts, and the need to maintain fiscal discipline to control inflation and spur economic growth has convinced governments to seek private sector resources (Panayotou 1998). Involvement of road users and other stakeholders in the road network planning has been found in some countries to provide the key to effective and efficient and financing measures particularly since governments are usually reluctant to increase taxes and user charges. There is therefore a need to consider involving urban road users on how to manage the road. If members of the community are to be made stakeholders they may be willing to pay more for roads, but only if the money is seen to be judiciously utilized which is not the case in the present situation. According to Adewunmi (undated) involvement of stakeholders in urban road network can create a surrogate market discipline which will encourage road administration to use resources efficiently. (Austin Otegbulu, 2011, p.4)

2.1.6. Drainage Maintenance Management System

2.1.6.1. Causes of Road Drainage Problem

Agbonkhese et.al, (2013) in their research stressed that: Poor maintenance, poorly executed construction jobs, negative attitude of residents and noncompliance to existing master plan of town has been the cause of poor road conditions. They concluded that poor drainage has led to a fast deterioration of most roads in Nigeria and government and respective bodies should also take into consideration, proper design, and maintenance culture to enable the constructed roads to be put to use to meet their designed life. Agbonkhese et al (2013). (Tiza, Michael Toryila, Iorver et.al. 2016, p.123)

The most common causes of road drainage problem were found related to improper road geometry, insufficient capacity of drainage structures, poor construction, and lack of proper maintenance. Magdi, (2016) (Tiza, Michael Toryila, Iorver et.al. 2016, p.123)

The lack of adequate waste collection and disposal system cause poor sanitation as it leads to the blockages of drains. Increased population, human activities and inflow materials into the area results in the generation of larger volumes of waste, coupled with irrepressible location of physical infrastructures such as offices, facilities, markets and residential structures which are located and built along natural erosion routes and drainage channels. (David O. Olukanni, et.al 2014, p.102) Thus, proper design, construction and maintenance practices should be adopted to keep roads drained. (Tiza, Michael Toryila, Iorver et.al. 2016, p.124)

The effect of poor drainage condition on road is very adverse. It causes the failure of road in different ways. Proper drainage system provided to the road increases the life of roads. But the improper drainage system causes the failure of the road at its early edge. Therefore effective road drainage should be taking into consideration during construction of roads. (Tiza, Michael Toryila, Iorver, et.al. 2016, p.124)

Also as this blockage exists, the road pavement attached to these drains is also under threat. Water builds up on the pavement (flood) thereby causing a wear and tear, with washing of bitumen and other road components into drains thereby causing further damage and leading to drain failures. (David O. Olukanni et.al. 2014, p.102)

The successful construction of a drainage system in a neighborhood does not guarantee a successful drainage project. Users need to be aware of operation and maintenance requirements at the neighborhood level. (UNCHS, 1986) (Dr. Jonathan Parkinson, 2003, p.125)

Some communities suffer from drainage problems not because they have no drains, but because the existing drainage system has collapsed, become blocked, or are otherwise in need of repair and rehabilitation. Many more will find that the nearest convenient point of discharge for a new drainage system is an existing primary drainage pipe or canal that needs attention if it is to function properly. Collapse and blockage are the principal types of drainage failure. Each

of these can have several causes. Collapse of drains can occur through: (World Health Organization, 1991, p.42)

- erosion of the bottom and sides of the drain (scouring);
- excessive pressure of water in the ground beneath and beside the drain lining;
- vehicles passing over or too close beside the drains;
- root growth, especially from nearby trees;
- Crown corrosion in closed drains containing sewage.
- The causes of blockage can be:
- accumulation of refuse, leaves and earth in the drain;
- structures such as houses or bridge piers erected in the drain and obstructing the flow;
- excessive vegetation growing in drainage channels;
- Silt deposited in low sections owing to misalignment or where the slope is insufficient and cleaning is not regular enough. (World Health Organization, 1991, p.42)

2.1.6.2. Definition of Drainage Maintenances

Drainage maintenance is preserving, repairing, and restoring the features of a road that contributes to keeping it in a safe, acceptable operation condition. The importance of maintenance work is that it protects the big investments communities have made in their roads and streets (M. Coughlan & George, 2007, p.62).

Drainage is the most important aspect that determines the performance of a road. Failure of roads is often attributed to poor drainage.

“The road with good drainage is a good road” is just as valid today as it ever was

Water, when allowed to enter the road structure has the effect of weakening the pavement layers and making them susceptible to the damaging effects of traffic. Water can enter the road structure in one of two ways; either by storm water

directly penetrating the surface or indirectly, by ground water infiltration. Storm water that falls on the road needs to be led away in a controlled manner. If allowed to flow too fast it will cause erosion of the edges, drains and the embankment slopes; and if allowed to float too slowly it will cause siltation in drains and culverts. If allowed to stagnate, the water will penetrate into the structure, through surface cracks etc., and also from the sides. In flat terrain, special efforts have to be made to obtain sufficient gradients for the side drains and also to find suitable outlets for them, such as natural streams. In some cases, lead-away drains can be used to convey water away from the road. Also, the drains may have to be made as broad and as deep as possible so that they become temporary catchments, providing the necessary extra time for the storm water to get away from the roadway area. In hilly and mountainous terrain, efforts will always have to be made to reduce the flow velocities in the drains and in the outlets the best preventive maintenance for roads is to maintain road drainage. This makes the road last longer. (Asia Foundation, 2008, p.20)

Successful drainage and subsurface maintenance depends on early detection of the problems before conditions require major action. Symptoms of drainage problems requiring attention include: puddles on the surface area, poor surface flow, slope erosion, clogged ditches, and pavement edge raveling, preliminary cracking pavement spall or pumping, and surface settlement. These symptoms indicate the start of failures which occur as soil particles are gradually washed away and as excess water seeps into the roadway reducing the load-carrying ability of the sub grade. Major failures caused by poor drainage conditions include washouts, slides, slip outs, pavement breakup, frost boils, and flood damage. (M. Coughlan & George, 2007, p.62)

Maintenance (World Health Organization, 1991, p.63)

- Routine drain cleaning
- Reporting of defects and blockages
- Twice-yearly inspection
- Repair

- Payment for maintenance
- Passing of by-laws regarding the use of drains
- Enforcement of by-laws.

For each activity, a decision is needed as to which individuals are to carry it out, when they will do so, how they will be organized and to whom they will be responsible. This means that during the planning stage, decisions must be taken about what the community will do in the future. The more decisions that can be taken during this planning stage, the better it is for the future of the project. (World Health Organization, 1991, p.63)

2.1.6.3. Objectives of Road Drainage and the Maintenance Task

The objective of road drainage maintenance is to ensure that its route is free from obstruction and to retain the cross section and the gradient. They must function properly so that surface water and ground water can drain freely and quickly away from the road. (Asia Foundation, 2008, p.21)

The objectives of road drainage can be broadly classified as:

- Prevention of accumulated surface water on or by the roadway and flowing onto the roadway.
- Interception of ground water from entering the road structure from beneath.
- Prevention of erosion of the roadway edges, drains, embankment slopes, cut slopes and the roadside itself.
- Conveying river and stream water across the roadway in an appropriate manner.

“Water is the worst enemy of any road. “It can:

1. Erode soil.
2. Weaken pavement.
3. Destroy shoulders and slopes.
4. Wash out culverts and embankments.

Regular site inspections, particularly during the rainy season will be an essential tool to clearly identify the problems. (Asia Foundation, 2008, p.21)

2.1.6.4. Type of Drainage Maintenances

Table 3: The Table Below Defines Maintenance Categories for Drainage.

Routine Maintenance	Preventive Maintenance	Major Maintenance
Replacement, repair and installation of curb, gutter, and riprap and under drain; cleaning, repairing or replacing culverts, storm sewers, erosion controls; reshaping drain-age ditches and channels.	Removal of debris and siltation from channels to prevent damage to structures or flooding of road-ways. Repair or replacement of slopes and/or riprap to prevent damage to structures or embankments.	Constructing new drainage channels or modification of drainage structures to increase drainage capacity. Performed only to correct a maintenance or safety problem or to protect public or private property.

(C. Michael Lee, 2016, p.12)

Successful drainage and maintenance depends on early detection of problems before conditions require major action. Signs of drainage problems requiring attention include: puddles on the surface area, poor surface flow, slope erosion, clogged ditches, pavement edge raveling, preliminary cracking, pavement pumping, and surface settlement (Charlotte, 2013). These signs indicate the start of failures which occur as soil particles are gradually washed away and as excess water seeps into the roadway reducing the load carrying ability of the sub grade. Major failures caused by poor drainage conditions include washouts, slides, slip outs, road and pavement breakup and flood damage (Nyuyo, 1993). From a drainage point of view, Nyuyo observes that pavement maintenance consists largely of sealing cracks, patching, and repairing deteriorated surfaces. It is a cost effective treatment to extend the life of the pavement before more expensive maintenance will be required. Stagnant water on or beside the roadway is a common sight of rainfall downpour yet it is a sign of future problems. Water soaks into the road structure unless the soil around and under it is relatively waterproof. The purpose of drainage design is to control the surface

runoff and to control the free water in the sub base and sub grade (Mwai, 2001). (Victor K. Rono, 2014, p.26)

2.1.6.5. Inspection of Closed Drains

Post-construction monitoring during the first year after installation is important for gauging the effectiveness of subsurface systems during operation and determining whether any system modifications are necessary. Monitoring inflow and outflow within pretreatment structures and control structures along with weather conditions can provide useful information about system performance during and after rain events. In addition, regular and frequent inspections during the first year would help to determine the appropriate activities and schedule for future maintenance. (New York City Department of Environmental Protection, 2012, p.60)

The inspection of closed drains is more difficult and dangerous, and should be carried out under expert supervision. The first step is to draw a sketch map of the system, if record drawings are not available. The map should show all existing manholes, inlets and other drainage structures. If the gap between any two manholes is very long compared to that between most others, it is likely that one or two other manholes have been buried or destroyed between them. From the regular manhole spacing, it should be possible to calculate the most likely location of a missing manhole. Local residents, who may know of buried manholes, should also be consulted. The probable sites of missing manholes should be excavated, to uncover them. (World Health Organization, 1991, p.45)
No one should enter any manhole until it has been adequately ventilated. As a precaution, the manholes upstream and downstream of the section to be inspected should be opened at least two hours beforehand. To save time, a number of manholes can be opened simultaneously. Further ventilation can be achieved by introducing the air hose from a compressor, if one is available. Inspection should start as far downstream as possible, and work upstream. Water in flooded manholes should be pumped out to the next manhole downstream using a sump pump, of the type used by construction firms for

excavations. Alternatively, the water could be bailed out with buckets or removed with a siphon, but this is likely to take a very long time. (World Health Organization, 1991, p.45)

Once the manhole has been ventilated, a further safety check is necessary to ensure that it is safe to enter. A lighted candle or a miner's safety lamp is lowered into the manhole. If the flame dies, it means that there is insufficient oxygen inside and that anyone entering the manhole could be suffocated by the gases produced by sewage and sediment. However, no naked light should be used until the manhole has been ventilated, as it could cause those gases to explode. (World Health Organization, 1991, p.45)

A final safety precaution, no less necessary, is that no one should enter a manhole without a lifeline. A spare lifeline should be ready for use if necessary. Access steps in an old manhole are liable to be seriously corroded and much less secure than they appear. They are often slippery. At least two people should remain above ground to pull out the third member of the party in case of emergency. They should never follow the third member into the manhole, even in an emergency, as they could all be killed. Even if the manhole is properly vented, the person inspecting it should disturb the settled sludge and silt as little as possible. These sometimes contain poisonous gases, which could be released when the sediment is agitated. If a drain is completely blocked so that it cannot be inspected, material should be removed only from the upstream end. (World Health Organization, 1991, p.45)

Routine post-construction inspections of subsurface systems are recommended to ensure continued performance and compliance with city codes and regulations. Licensed professionals and contractors can conduct inspection activities as can site maintenance staff, landscapers, septic professionals and other trained professionals. In addition, property owners can inspect debris and sediment deposits at drains and inlets, drain down of the water in the system at the observation well(s) and record general observations on the surface in the

area of the subsurface system. (New York City Department of Environmental Protection, 2012, p.60)

Drainage pipes of less than 1 m in diameter cannot be entered safely, and great care should be taken in entering larger drains. The dangers include poisonous gas, cave-ins, sudden rushes of water from clogged sections or from storms, and even wild animals. Naked lights such as matches or candles should not be used in a closed sewer or within 3 m of any open manhole. A miner's safety lamp is preferable to a flashlight, to avoid the risk of explosions. (World Health Organization, 1991, p.46)

2.1.6.6. Maintenance Methods – Roadside Areas

Including the shoulders and side slopes, most roadside area maintenance activities can be achieved by labour, and are Suitable works for a mobile or local gang or an individual length man living close to the road. (Asia Foundation, 2008, p.27)

1. SHOULDERS

A. defect: obstructions such as rocks, trees or tree branches, soil heaps and abandoned vehicles/debris.

Main Causes

- Material fallen from slopes or trees, material washed onto the shoulders.
- Debris left by road users.

If Neglected

- Hazard to road users.
- Obstruction of water flow from carriageway.

Remedies

- Remove obstructions.

B. Defect: Shoulder Higher than Carriageway

Main Causes

• Carriageway surface material has collected on the shoulder by the action of traffic/water.

• Soil from the cutting has slipped onto the shoulder.

• Vegetation has trapped material on the shoulder.

• Shoulder material has been displaced by the action of traffic.

(Asia Foundation, 2008, p.27)

If Neglected

• Surface water can pond at the edge of the carriageway and weaken the pavement and shoulder.

• Danger of accidents.

• Excess material may block the roadside ditch.

Remedies

• Reshape or re-grade shoulder surface to the correct level.

• Vegetation control.

C. Defect: Shoulder Lower than Carriageway

D. Defect: Ruts or Depressions (Asia Foundation, 2008, p.28)

Main Causes

• Traffic has been travelling on the shoulder and material has been worn away.

• Water erosion of the shoulder, settlement of the shoulder, the carriageway has been overlaid leaving the shoulder surface lower than the pavement.

If neglected

• Inadequate support for the road pavement.

• Water collects and softens the shoulder and pavement foundation.

• The edge of the pavement will break when vehicle wheels run over it, increasing the risk of accidents.

E. Defect: High Vegetation on Shoulders

Main Causes

Grass, weeds, bushes or trees have been allowed to grow unchecked.

If neglected

• Surface water can pond at the edge of the carriageway and weaken the pavement. (Asia Foundation, 2008, p.28)

• Silt accumulates at the edge of the carriageway; the visibility for road users is reduced, with increased risk of accidents with persons or animals.

• Increased fire hazard in the dry season.

Remedies

• Vegetation control. (Asia Foundation, 2008, p.29)

2. DRAINS

A. Defect: Obstructions

Main Causes

• Vegetation growth, bushes, fallen trees, debris, loose silt, loose rocks. If neglected

• Blockage of ditch.

Remedies

• Clearing and cleaning.

B. Defect: Silting

Main Causes

• Invert slope is too flat; the water cannot flow at sufficient speed. If neglected

• Ditch blockage.

Remedies

• Deepen ditch (de-silting), and/or provide new turnouts.

• Where deepening or turnouts are not possible because of topography, the construction of a new culvert with a drop-inlet may be possible, in order to discharge water onto the other side of the road.

C. Defect: Ponding in Drains and on Shoulders

Main Causes

• The ditch cross-section is too small; the ditch gradient is too flat. If neglected

• The shoulder material becomes soft and can easily erode.

• The pavement can also be flooded and thereby weakened.

Remedies (Asia Foundation, 2008, p.29)

• Deepen ditch.

• Provide new turnout.

D. Defect: Drain Cross-Section Destroyed (Unlined Drain)

Main Causes

• Vehicular or animal traffic; cave-in.

If neglected

• Partial silting will result if the ditch sides have collapsed.

• Erosion can start where water flow passes the blocked section.

Remedies

• Reshape/re-grade ditch, line drain. (Asia Foundation, 2008, p.29)

E. Defect: Invert and Sides of Drains are eroded

Main Causes

• Invert slope is too steep.

If neglected

• The water flows at high speed and starts eroding the soil. The ditch becomes deeper (ravine). The sides then cave-in, the road shoulder and even part of the carriageway can be washed away.

Remedies

Erosion control:

• Re-grade/realign drains.

• Provide repair scour protection.

• Line drain slopes and invert.

• Construct cascade.

F. Defect: Drain Lining is damaged

Main Causes

• Poor construction workmanship.

• Soil settlement, erosion of soil under ditch lining.

• Poor alignment or sudden change in flow direction.

If neglected

• When flowing water reaches the soil protected by the lining, erosion starts. (Asia Foundation, 2008, p.30)

• The amount of soil washed away increases; the lining is further damaged by loss of support, leading to complete destruction of the lining.

Remedies

Erosion control:

• Repair lining.

• Realign drain.

G. Defect at Drain Outfall (Asia Foundation, 2008, p.30)

Main Causes

• Flow too fast.

• Flow too concentrated for the soil at the outfall to resist.

If neglected

• Erosion will continue back into the ditch and increase in the area of the outfall.

• The erosion may eventually threaten the road as well as the surrounding land.

Remedies

Reduce water flow and speed:

• Realign drain to flatter gradient.

• Provide new turnout drain, upstream from existing.

Reduce impact at outfall:

• Construct cascade.

• Construct flow spreader.

Erosion control for the soil:

• Turfing.

• Wattling.

• Stone pitching.

3. MANHOLES AND DRAINAGE PIPES

A. Defect: Water Overflowing at Manhole

Main Causes

• The manhole or connected underground pipes are blocked and water cannot flow as intended. (Asia Foundation, 2008, p.31)

If neglected

• Flooding of road shoulder or carriageway.

• Drainage system becomes ineffective.

• Danger of earth slip or weakening of the pavement.

Remedies

• Clear manhole and underground pipes.

B. Defect: Manhole Cover or Grating is Missing/Damaged

Main Causes

• Accident, vandalism.

If neglected

• Open manholes become a danger to people and animals. Vegetation and debris have uncontrolled access and blockage can occur.

Remedies

• Replace manhole cover or grating. (Asia Foundation, 2008, p.31)

C. Defect: Manhole is covered with Soil and Vegetation

Main Causes

• Silting of the ground area at manhole; manhole cover level possibly set too low. If neglected

• Possible blockage of the drainage system at the manhole, due to an undetected accumulation of silt in the manhole.

Remedies

• Clear manhole area.

Public require education on:

• Not burning trash in drainage ways.

• Collecting leaves and other debris in drainage ways.

• Cleaning of drainage ways.

2.1.6.7. Levels of Service for Roadside Maintenance.

Table 4 Levels of Service for Roadside Maintenance.

Component	Desirable Level	Acceptable Level	Tolerable Level
Drainage	Maintain function with minimum blockage, ponding, or erosion.	Maintain function with some blockage, ponding, or erosion with no dam-age to highway or private property.	Same as Acceptable level.

Source (C. Michael Lee, 2016, p.26)

The problem given above should be solved immediately; otherwise the road network is unsuitable for use before its lifetime. Some remedial measures should be suggested to eliminate all the problems. Maintenance work should be done regularly by the authority. The people should be aware about the traffic rules and use the road properly (Mr.Dipanjan Mukherjee, 2014, p.50)

2.1.6.8. Maintenance - Technical Aspects

The most important maintenance task is to remove refuse, silt and other solid material from the drains. All drains should be cleaned at least twice a year, preferably at the start and end of the rainy season. Some drains, especially the secondary drains and house connections, will need to be cleared more frequently. Small open channels in flat areas are likely to require cleaning on a weekly basis. Unlined channels need to be regularly cleared of vegetation. It is important to establish the cleaning of drains as a routine activity at regular intervals, and not wait until the system fails as a result of blockage. Repairing the damage done when the system fails, including damage to the drains themselves can cost far more than regular preventive maintenance. Drain clearing must be coordinated with the collection and disposal of solid waste, so that solid material removed from the drains will not be left where rain can wash it back or where it

can be a nuisance and a health hazard, encouraging the breeding of rats and flies. (World Health Organization, 1991, p.49)

2.1.6.9. Maintenance - Institutional Aspects

The need to coordinate drainage maintenance with solid waste disposal has already been mentioned. Coordination is necessary for two reasons. First, the solids removed from the drain must be adequately disposed of. Second, the drains cannot be kept clear without effective solid waste disposal. If solid wastes are not collected regularly, residents will have little choice but to throw their rubbish into the drainage channels, or to dump it in the streets and open spaces where it will be dispersed by storm water, wind and animals, much of it eventually reaching the drains. Maintenance, including the inspection, cleaning and repair of the drainage system, must be institutionalized if it is to be kept up throughout the life of the system. For this reason, the ultimate responsibility should preferably be with the municipality, which has paid staff who can carry out the work. It is much more difficult to mobilize a community on a voluntary basis to carry out a routine task, year after year, than to win their active participation for the limited period required for construction. Nevertheless, there is ample scope for participation by the community in drainage maintenance. (World Health Organization, 1991, p.53)

2.1.7. Effect of Poor Maintenance

The construction of drainages will be a waste when not properly maintained. The performance of a drain is attributed not only to how effective it is utilized, but also to the conditions therein. These conditions include the presence of waste, the presence of growing plants and leakages. These challenges do not only retard flow in the drain, but they also increase overflow conditions. It was clear that the drainage challenges within these areas were as a result of poor maintenance of the drains themselves. This has created habitats for growing weeds and stagnation of water. (David O. Olukanni et.al. 2014, p.102)

Poor drainage maintenance does not always give rise to problems immediately. The accumulation of sediment or rubbish in the drains and the deterioration of

the system can occur progressively over a period of time, unnoticed until a major effort is needed to restore the system to good working order. In addition to organizing routine maintenance, the drainage committee would be well advised to establish one day each year when the community is mobilized to give the whole system a thorough cleaning and overhaul. It would be most convenient to fix this day near the end of the dry season, when there is little water in the drains so that cleaning and repair can be carried out easily. (World Health Organization, 1991, p.68)

The drainages that were constructed in these areas lacked proper maintenance, as debris and waste materials were dumped into the drain thereby inhibiting flow of water in the drains. This indiscriminate attitude occurred majorly by road users who drop waste materials into the drains owing to insufficient waste bins around.. (David O. Olukanni et.al. 2014, p.102)

2.1.8. Community Participation and Involvement

Often, one of the best solutions for maintenance is for community members to be responsible for the management of the drainage system, as the regular inspection and cleaning of drains is an important task that can be performed without specialized skills. (Howard, 2002) (Dr Jonathan Parkinson, 2003.p.125)
Clearly, community participation in maintenance needs proper planning and organization. However, if the municipality neglects its responsibility for maintaining the primary drainage system, water from the neighborhood and adjoining areas may back up and cause flooding, causing residents to lose heart. A community has the best chance of achieving successful maintenance when it works in partnership with the municipality. (World Health Organization, 1991, p. 68)
An enhanced management role for user communities is a way of increasing cost-effectiveness, improving reliability and ensuring sustainability, by placing a larger share of the responsibility in the hands of the users themselves. (Lammerink, M P and E Bolt, 2002) (Dr. Jonathan Parkinson, 2003, p.125)

2.1.9. Participation in Planning

A drainage system, like any other item of infrastructure, is part of the built environment of a community, and residents may find it inappropriate and unacceptable if they have not participated in the key planning decisions. Traditionally, the planning and design of urban surface water drainage systems have been carried out by governmental or municipal agencies, without the involvement of the local residents and with limited, if any, consultation with them. However, the technical and planning staff of such agencies do not normally live in low-income communities and can easily be mistaken about local needs, customs and aspirations unless the community is given a chance to state its views. (World Health Organization, 1991, p.55)

Open drains take up a certain amount of land, a scarce commodity in many low-income urban communities and one that residents may be unwilling to sacrifice unless they are convinced that it is for their benefit. Houses may have to be relocated and rebuilt to make way for new drains, and residents must be dissuaded from erecting new structures that would obstruct the drainage system. The position is complicated by the problems of land tenure which beset many urban slums and shanty towns. For example, the conventional procedures used by a municipality for compulsory purchase of land are clearly inapplicable in a community of squatters with no legal title to the land on which they have built. The land requirement of a drainage system can make it a burning issue and can give rise to great bitterness unless the community has participated in planning the system. (World Health Organization, 1991, p.55)

A drainage system is very vulnerable to abuse, even by a single member of the community. A resident can effectively block a drainage line by dumping a moderate amount of rubbish in it, and thus render useless the whole system upstream. Deliberate blockage and other forms of sabotage are not unknown, but apathy and neglect can have equally serious means of generating the interest and involvement of local residents, and is essential for the success of a drainage project. (World Health Organization, 1991, p.55)

However, the organization of community members who are ultimately responsible for actually carrying out the cleaning of the drains can be problematic. (Dr. Jonathan Parkinson, 2003, p.125)

Residents can also contribute much to the design of a drainage system because of their detailed knowledge of the area. For example, the shortage of accurate hydrological data for urban areas can easily lead to unnecessarily expensive drainage systems being designed, unless witnesses' recollections of past floods are taken into account. Many other types of information can be collected by residents on a voluntary basis, avoiding the need for expensive surveys. (World Health Organization, 1991, p.55)

This can be achieved most effectively by establishing a special drainage committee in the neighborhood, or by adding drainage to the list of responsibilities of an already active community committee established for the management of other forms for environmental services (such as water supply and solid waste collection and disposal) (Dr. Jonathan Parkinson, 2003, p.125)

2.1.9.1. Community Institutions

Community participation is not a spontaneous, automatic process. It requires an initiative to launch it, and management to organize it. In practice, communities can participate only through community institutions. On the other hand, these institutions do not need to be created out of nothing. A low-income urban community is not the unorganized mass it may seem to outsiders. Usually, a variety of institutions are already in existence, some of them with a high degree of organization and considerable power to influence people's attitudes and behavior. They are of many different kinds, such as the following: (World Health Organization, 1991, p.57)

- residents' associations and amenity groups
- women's organizations,
- political parties,
- labour unions,

- religious bodies,
- cultural associations,
- ethnic or “home-boy” associations,
- Rotating credit associations,
- Burial societies,
- Schools, parent-teacher associations,
- Health posts, health committees, community health workers.

Some of them may be formally recognized and affiliated to regional or national bodies. Others may have developed informally in response to specific local needs. Their activities and influence often range much wider than the purposes for which they were originally established. They are often far more active and influential in low-income communities than the corresponding institutions in wealthier neighborhoods. In addition, some individuals may be recognized informally as leaders in the community owing to their education, wealth, age or experience. (World Health Organization, 1991, p.57)

2.1.9.2. Participation in Maintenance

The maintenance of a drainage system requires specific institutional arrangements, preferably with a municipal department assuming the ultimate responsibility for this task. Whether or not a municipal department assumes the responsibility for maintenance, a neighborhood drainage committee can at least monitor the functioning of the system and report defects and deficiencies to the officials responsible. In many cases, the community can also carry out much of the routine maintenance work. There must then be good coordination and a clear division of responsibilities. Residents must know to whom they should report any problems such as damage or blockages. It is certainly advisable that the community should appoint a drainage committee to plan and supervise the maintenance work. This committee should liaise with the municipality to ensure the prompt collection of solids removed from the drains and the unhindered discharge of storm water into the primary drainage system linking their

neighborhood with the receiving water body. (World Health Organization, 1991, p. 56)

In many situations, it may be more appropriate to contract the services of a member of the local community to be responsible for drain cleaning. This person may be contracted by a management committee, which collects a small fee from community members to pay for the cleaning services. This may overcome problems of reliance on the active participation of all households in drain-cleaning activities, when some may perceive these activities to be degrading or unnecessary especially where they do not suffer from any of the problems related to poor draining. (Dr. Jonathan Parkinson, 2003, p.125)

One possibility is for each household to take responsibility for the section of drain passing through or in front of its plot. However, if this is to work successfully, it has two prerequisites: (1) the arrangement must be accepted by the community at large; and (2) some additional procedure is needed to monitor and bring pressure to bear on those who neglect their responsibility. The process is illustrated by the example of one self-help upgrading scheme in Bandung, Indonesia, where house owners agreed to be responsible for the daily cleaning of the drains in front of their houses. A neighborhood coordinator inspected the drains twice a week and recorded his findings. The response to the friendly inspections was very good, and the inspector assisted in the manufacture of simple scoops and scrapers to facilitate the cleaning of the small culverts under the house entrances. Soon, it became a daily routine performed by every self-respecting householder. (World Health Organization, 1991, p.67)

The other approach is for a specific group of residents to clean the whole system. This has the advantage that they can be supplied with any special equipment needed, such as shovels and handcarts or wheelbarrows. The composition of the group could change regularly on a rotating basis so that everyone takes a turn, under the supervision of the standing drainage committee. Alternatively, they could be a fixed section of the community, such as the members of a youth

organization. Whether the membership of the group is fixed or rotating, they must have some incentive to carry out the work, or be subject to some sanction if they fail to do so (World Health Organization, 1991, p.67)

2.1.9.3. Creating Awareness

A range of methods can be used to give publicity to the drainage committee and its objectives, including public meetings, posters and door-to-door canvassing. Schoolchildren are a particularly valuable resource. They are usually more ready to accept new ideas, they have time and energy which can be mobilized for various activities, and they can influence their families at home. However, people's attitudes and behavior are not easily influenced by a one-way flow of information and exhortations to participate. A far more effective strategy is to stimulate discussion in such a way that residents come to see for themselves the advantages of contributing towards a drainage scheme and the importance of a responsible attitude towards it. (World Health Organization, 1991, p.59)

2.1.9.4. The 4A Philosophy

The 4A philosophy is based on the assertion that for new technologies or response initiatives to be successfully implemented, reform approaches need to be designed from the end user or recipient's point of view. It is argued that the value of this receptivity concept is that it assists with identifying the types and structures of policy mechanisms needed to improve practice (Brown et al. 2007). The 4A receptivity attributes assume that individuals, agencies and organizations (Ellis, J.B. et.al. 2009, p.15)

- should be aware of a problem and need for a "solution" (or response) i.e. **a**wareness
- can relate sufficiently to the potential benefits to commit effort to implement "responses" i.e. **a**ssociation
- have requisite skills and resources to implement and support solutions i.e. **a**cquisition
- have appropriate incentives to promote response implementation i.e. application (Ellis, J.B. et.al. 2009, p.15)

Table 5: Assessment Variables for 4A's Receptivity

AWARENESS	ASSOCIATION	ACQUISITION	APPLICATION
available data and information - awareness of urban drainage system - visible flood and/or pollution problems - environmental and social damage and/or costs - lack of opportunities for participation in decision-making process	- community perceptions - stakeholder commitment - potential social amenity - potential environmental outcomes - potential public health outcomes	technical feasibility - professional knowledge government/agency policy - regulations and approvals - stakeholder commitment - costs - property access - management arrangements	implementation timescales - effective institutional arrangements - stakeholder commitment

Source (Ellis, J.B. et.al. 2009, p.16)

2.1.9.5. Lack of Community Participation

One of the main obstructions preventing the successful control of storm runoff measures either by structural or non-structural measures is the absence of community participation in providing solutions to urban drainage problems. Community participation simply depends on the desire and ability to organize themselves, strict compliance to societal goals and rules, and providing medium of direct communication by the appropriate municipal administration. This provides linkages in which municipal authorities can pass useful information to residents, and vice versa. It can also develop into participatory function where well-defined priorities that pertain to urban drainage can be evaluated. As a result of compliance, the level of technical information as well as environmental education increases. The absence of community participation gives room for repetition of earlier errors in tackling drainage problems and also low investments in urban facilities. (David O. Olukanni et.al. 2014, p.103)

2.2. Empirical Review

The empirical review discusses the drainage maintenance management system of Addis Ababa city.

2.2.1. History of Addis Ababa City Roads and Addis Ababa City Roads Authority.

Emperor *Theodros* got missionaries to create a cannon so called *sebastopol* by force and it was deemed necessary to find access road to transport the cannon from the site of creation all the way to mount *Mekdela,* and the road was eventually constructed by coordinating labor from local community, which is presumed to be marking the beginning of road construction in Ethiopia. Afterwards, the ingenuity of Emperor *Menelik* to introduce civilization in the country resulted in commencement of road construction works by importing road construction compacting roller and chariot in 1886, and subsequently construction of Addis Ababa-*Addis Alem* road was carried out after introduction of the first car in Ethiopia. The second road was constructed along the route from Palace to British Embassy. (Addis Ababa City Road Authority, 2014, p.89) Emperor *Menelik's* successors, particularly, Emperor *Haile Selassie* had somehow managed to continue with roads construction works following the footsteps of his predecessor; and as the available evidence shows, road construction works had continued even during Italian occupation but also during the *Derg* regime.

Upon its establishment by Regulation No 7 and 1998 Proclamation, Addis Ababa Roads Authority has carried out several activities and brought about major changes. This is evident in construction of 2600 km 7 meter width asphalt road, 4,318 km cobble stone pavement and gravel road 2,128 km pedestrian sideway, 4,000 km two-way drainage line, and a total length of 5,918 km road with 7 meter width, which increased road coverage of the City to 22.2%. This significant changes show the strengthening of the subordinate and the General Manager of Addis Ababa City Road Authority. Roads are important public assets it facilitate

growth and encourage investments. Transport has an impact on productivity. On-time delivery and free traffic flow are essential factors for development. Road affect the aggregate productivity of the economy (World Bank, 1992) (Austin Otegbulu, 2011, p.8)

Now a day Addis Ababa city road Authority has more than 5,980 employees. The staff is mixed staffing or contingent workers. The staff includes all full times employees, temporaries, par-timers, leased workers (out sources) (Addis Ababa City Road Authority, 2016, p.121)

Drainage and sewerage works will be handled through the use of two approaches: the first approach involves digging of deep septic tanks and disposal through sewerage line along the households; on the other hand, sewerages will be suctioned by sewerage disposal on the spot from rest rooms and deep septic tank. These should be in no way linked to drainage lines constructed on road side.

The second type uses drainage maintenance methods; under the first annual plan drainage clearing and cleaning works will be carried out ; and under the second plan, drainage clearing works will be carried out on the basis of needs upon tips from local community,

Today the drainage line reached more than 4,000 km two- way drainage line but there is no master drainage plan. (Addis Ababa City Road Authority, 2015, p.13) the master drainage plan show all detailed information about the city drainage system like location, layout the outfalls inlets directions distances depths and the size of the drains the record of rain falls where water is coming from and where water is going in addition to this climatic and hydrological data includes in the master drainage plan the absence of master drainage plan create a serious drainage problem in the city.

Similarly, there is a problem in the construction stage in poorly constructed drains the authority tries to minimize the inspection and supervision problem also some employees were punished in the inspection and supervision related cases (Addis Ababa City Road Authority, 2015, p.13)

Lastly, the city drainage problem occurs when peoples misuse the drainage facilities by throwing solid wastes in to a drainage system. Those solid wastes like packages and plastic materials will potentially block the flow of water in the drainage system. In addition to these problems informal sector businesses like street food venders, street petty traders and illegal street car wash service providers affect the drainage systems by throwing solid and liquid wastes to the drainage system. (Addis Ababa City Road Authority, 2014, p.79) Similarly in Addis Ababa city due to multiple road construction and building projects suffocate the road as well as fill the drainage systems with construction materials wastes and excavation. Heavy truck carry excavated top soil and wastes from work sites to deposits (fills) without safety measure taken in to account and fill the roads with wastes which later get into the drainage system. In such cases soils and other wastes either fill the drainage system or potentially pile up to block the flow of water in to the drainage system.

The most part of maintenance will be performed by engaging the elderly, men and women. This is because of poor attitude and poor work habits more over unattractive salaries are the main reasons. However, these reduce the financial or economical dependency of women. In developing countries many women's are dependent on their husbands they have no economic freedom this helps to cover their miscellaneous cost and raise the economic benefit of women.

Inspection, cleaning or removing solid wastes from the manholes and closing the manhole cover securely are the main tasks of drainage maintenance section. Commonly the manholes covers are made by cement it's a slab of concert they are used crow bar tool to open the manhole covers. Crow bar, mattocks, spade, and pick axes, trowels are the common hand tools of drainage maintenance.

For drainage maintenance personnel Safety equipment's are mandatory. It helps to protect from harmful things Sometimes sewerage linked with drainage it transfer diseases. Because of lack of awareness and negativity peoples fill rusted nails, derbies, broken glasses; those things are harmful for maintenance employees to prevent this Addis Ababa City Road Authority gives training on

safety, health care and work place hazardous things. In addition to this the Authority formulates safety committee. (Addis Ababa City road Authority, 2008, p.10) however, the maintenance employees are not dressed protective equipment's such as safety shoes, gloves, helmets, and face shields goggles. This is because of low salary and high cost of living the employees may be sold the safety equipment's or on time supply problem and quality materials are the main reasons of this problem.

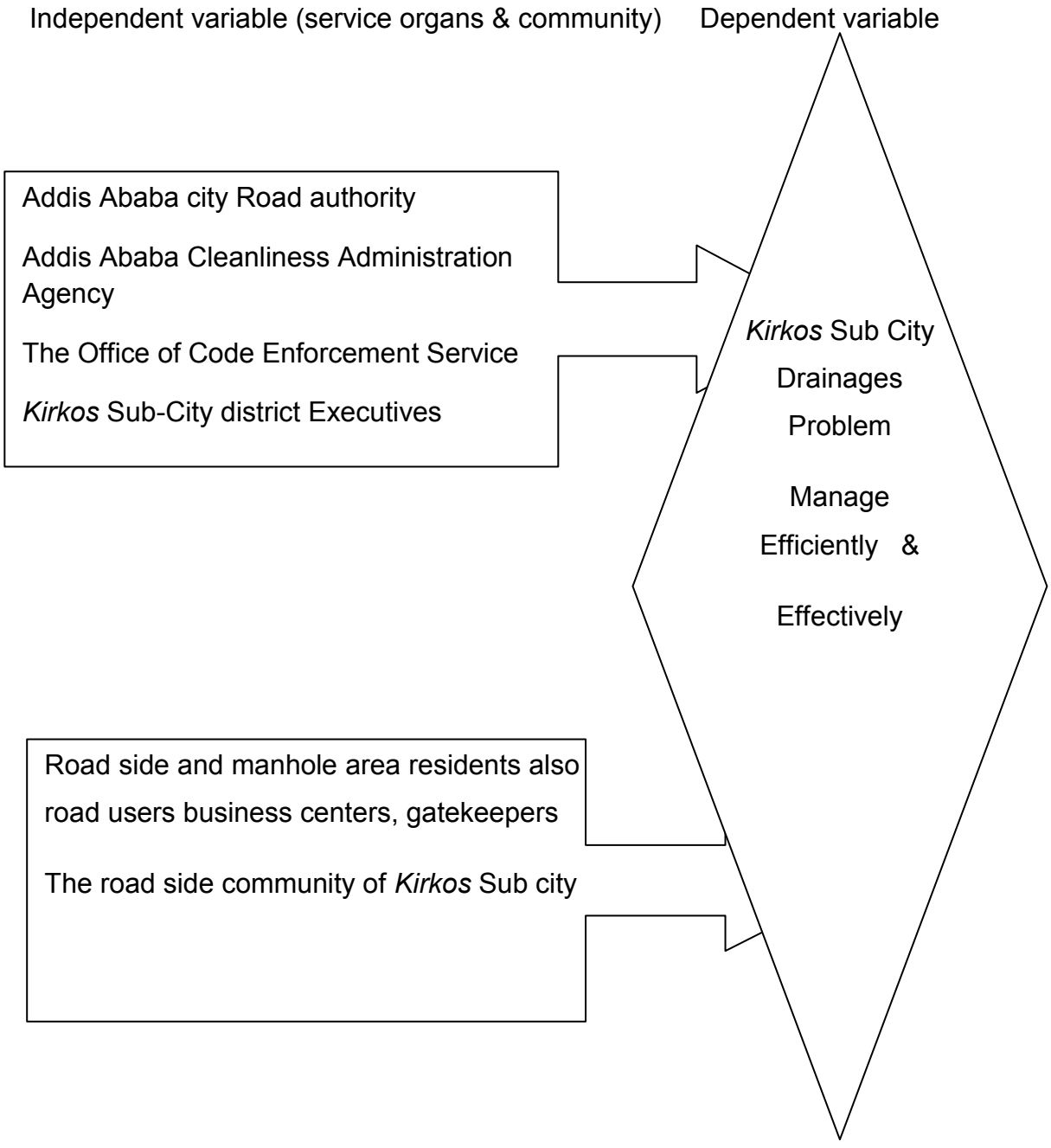
2.3. Conclusion

It will be essential to form a Community committee that is in charge of persuading, coordinating and mobilizing educated youths who are close to change in close collaboration with executive bodies of the city administration at all tiers down to *Woreda* structures while submitting recommendations for rapid maintenance by identifying poor drainage problems, and drawing programs on the basis of studies through compilation of complete information and monitoring.

2.4. Theoretical and Conceptual Framework

The theories the researcher use Peter Migosi used it in the study of Effects of Urban Storm water Management Strategy in Reducing Flooding; a Case of Mombasa it is based on a synergy of the Piaget's theory of Cognitive development, Functionalism theory and the path goal theory of leadership whose modern development is attributed to Martin Evans and Robert House (1964) (Peter Migosi, 2014, p.83) applied in this study this theory holds that the researcher would expect two independent variables. The first one is Addis Ababa city government executives & municipal service organs. The second variable is *Kirkos* Sub city community. The outcomes of those independent variables were challenge or hard to manage the dependent variable *Kirkos* Sub City sewerage and drainages maintenance management system.

Key variables



CHAPTER THREE

3. RESEARCH METHODOLOGY

The research was employed the mixed or combined forms of both quantitative and qualitative methods. Quantitative and qualitative methods of data collection were often employed in support of each other.

3.1. Research Design

The purpose of this study is assessing the challenges of sewerage and drainages maintenance management system in Addis Ababa in the case of *Kirkos* sub city. Accordingly, as can be seen from the research problem Exploratory Research design is appropriate, because the exploratory studies help to clarify and define the nature of the drainage problem in the sub city also it helps to understand the drainage causes. The major emphasis in such studies is on the discovery of ideas and insights (C,R,Kothari**,** 2004, p. 36)

3.2. Sampling Design

The researcher clearly define the population or the universe the sampling unit and the size of the sample.

3.3. Total Population or Universe

For the success of this study the researcher was clearly identify the population. The attributes that are the objects of the study are referred to as a characteristic and the units processing them are called as elementary units. The aggregate of such units is generally described as population. (C.R.Kothari, 1985, p.153) According to Addis Ababa City Road Authority drainage grade, from other sub city *Kirkos* sub city roads has critical drainage problems. The detailed information of the roads which have poor drainage system was listed below.

Table 6: Addis Ababa City Drainages Grade

Sub city	Surface drainage length	No of manholes	Grade
Addis Ketema sub city	29010.1 meter	1426 manholes	Poor
Akaky Kaliti sub city	28093 meter	----------	Poor
Bole sub city	16532 meter	827 manholes	Poor
Gullele sub city	8768 meter	438 manholes	Poor
Kirkos sub city	72002 meter	3600 manholes	Poor
Kolefe Keranio Sub city	10287 meter	514 manholes	Poor
Ledita sub city	29423 meter	1177 manholes	Poor
Nefase Silk Lafto sub city	42681 meter	1732 manholes	Poor
Yeka sub city	10610 meter	494 manholes	Poor
Arada sub city	34945 meter	1747 manholes	Poor

(Addis Ababa City Road Authority, 2016)

3.4. Size of Sample

Yamane (1967:886) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes A 95% confidence level and P = .5 is assumed (Glenn D. Israel 1992, p.4)

$$n = \frac{N}{1+N\,(e)^2}$$

Where

n is the sample size

N is the population size

e is the level of precision

$$n = \frac{N}{1+N\,(e)^2} \qquad n = \frac{235{,}441}{1+235{,}441\,(0.05)^2} = 236.02$$

Approximately 237 respondents involve in the sample survey.

Samples were collected from communities on roads with identified poor drainage problems, including security guards of businesses and offices as well as residents around roads, feeder roads and manholes.

Addis Ababa City Roads Authority of Addis Ababa City Administration was established by proclamation to carry out construction and maintenance of roads, bridges and drainage lines and ditches through executive structures established at all levels down to *Woreda* tiers. In this respect, samples have been taken from pertinent drainage cleaners and civil engineers. Second samples were also taken from Addis Ababa Cleanliness Administration Agency in respect of day to day observations of street sweepers or cleaners of drainage manholes. Third samples have been collected from Office of Code Enforcement Service which was established by Proclamation to monitor illegal drainage activities, and *Kirkos* Sub City Executive bodies.

3.5. Sampling Method

The researcher used in probability sampling method stratified sampling techniques and in non-probability sampling method purposive and convenience sampling technique was used for civil engineers and district executives.

To obtain a good sample, the researcher identifying which *woreda* is the serious poor drainage roads are located. These help to dispatched questionnaires in a proper proportion. One *woreda* proportionally larger in number of poor drainage than another *woreda*, the sample size should also be proportionally larger to select suitable and accurate data/sample. In order to get the sample proportion of each district or *woreda* the researcher use the following formula i.e. Sample proportion (%) = number of poor drainage in each *woreda* divided for total number of drainages multiple by total sample size.

Table 7: Sample proportion of each district

Kirkos sub city *woreda*	Number of poor drainage	Sample proportion (%)	Sample
Woreda 8	8	8÷27*237	70.22
Woreda 7	4	4÷27*237	35.11
Woreda 6	2	2÷27*237	17.55
Woreda 1	3	3÷27*237	26.33
Woreda 3	1	1÷27*237	8.777
Woreda 5	1	1÷27*237	8.777
Woreda 9	2	2÷27*237	17.55
Woreda 10	2	2÷27*237	17.55
Woreda 4	4	4÷27*237	35.11
Total	27 poor drainage roads		237 samples

3.6. Source of Data

For the purpose of this study the researcher use both primary and secondary data for primary source observation was one primary data collection method. The researcher can capture the whole events as it's occurred like uncovered manholes over flow of sewerage and drainage . . . etc a statement about a picture being worth a thousand words might seem trite, but there is no substitute for "seeing" the variable or the data. (Waltenburg, Eric and McLauchlan, William, 2012, p.4) because of this observation is appropriate method. The researcher taking photographs Furthermore unstructured interview again closed and open ended questionnaires includes in the primary source. These methods help to obtain fresh, also depth information easily. (C.R.Kothari**,** 2004, p.98)

For two independent variables the researcher prepared two different questionnaires the first one was to responsible municipal service organs and the second one questionnaire was to *Kirkos* sub city communities on roads with identified poor drainage problems, including security guards of businesses and offices as well as residents around roads, feeder roads and manholes. In addition to this the questions are translated in to Amharic language this help to be more comfortable for respondents and avoid technical terms or jargon words again it avoid misunderstandings.

In the same way the researcher use secondary source of data. The researcher gathered different soft copy's, current magazines and data's which is currently operational appearing time and again to concern, these were different research papers, books, magazines and newspapers.

3.7. Data Analysis and Interpretation

The data analysis method was exploratory method "Exploratory data analysis is detective work – numerical detective work – or counting detective work – or graphical detective work" (Tukey 1977, 1) (Waltenburg, Eric and McLauchlan, William, 2012, p.8) Questionnaires are presented in tabular form then analyzed. The data of the sample respondents are presented through percentage, mean, and standard deviation.

CHAPTER FOUR

4. DATA RESULTS AND ANALYSIS

As per the plan the researcher put in place the information acquired in entering practically has analyzed in the chapter hereto.

The researcher test the reliability and validity of the data collected through questioners by using Cronbach's alpha coefficient. Reliability as an attribute of an instrument used to measure consistency.

Cronbach's basic equation for alpha

$$a = \frac{n}{n-1}\left[1 - \frac{EVi}{V\,test}\right]$$

n = number of questions

EVi = variance of scores on each question

Vtest = total variance of overall scores

$$a = \frac{26}{26-1}\left[1 - \frac{3.115}{15.482}\right] = 0.83$$

A commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha is as follows

Cronbach's alpha	**Internal consistency**
α = 0.9	Excellent (High-Stakes testing)
0.7 = α < 0.9	Good (Low-Stakes testing)
0.6 = α < 0.7	Acceptable
0.5 = α < 0.6	Poor
α < 0.5	Unacceptable

(Vijaya Manerikar & Sumeet Manerikar, 2015, p.118)

The Cronbach's alpha for data collected for 26 items is 0.83 a rule of thumb that has been advocated in the literature (Vijaya Manerikar & Sumeet Manerikar, 2015, p.118) to require α to equal 0.70 or exceed it before the items are considered internally consistent. The Cronbach's alpha is 0.83 this indicate used is valid and the data are consistent the Cronbach's alpha is ranged in good measure of Internal consistency.

The researcher before making analyzing each every question and conducting interviews thereby have collected such information/data in clearly stating that interviewee have provide their information with due consent without pressure as objectives of the research shall be used for academic purpose and all responses will remain confidential and all respondents will remain anonymous as the data will be presented also analyzed in groups. In addition to this the researcher clearly stating that there is no right or wrong answers for the questions. (See Appendices)

It has analyzed in the two tables hereunder pertaining to how much questionnaire has distributed to *Woreda's* and how much data collected as well as general back ground of the sub city and drainage problems as they know problems of drainage closely and deeply in which they are victim of the problem and hence they are owners of the affairs which concerned with the affair directly and correct information would be able to acquire from them.

4.1. Response Rate

The researcher was distributed 237 questionnaires to respondents. Addis Ababa city municipal service organs and *Kirkos* sub city residents were participated in this study. The sample proportion, number of questionnaires distributed in each *woreda* and number of questionnaires received are presented in the table.

Table 8: Response Rate

Kirkos sub city *woreda*	Number of poor drainage roads	Sample proportion (%)	Sample	Number of questionnaires distributed in each *woreda*	Number of questionnaires received	Percentage
Woreda 8	8	8÷27*237	70.22	71	56	79 %
Woreda 7	4	4÷27*237	35.11	36	28	78 %
Woreda 6	2	2÷27*237	17.55	17	10	59 %
Woreda 1	3	3÷27*237	26.33	26	17	65 %
Woreda 3	1	1÷27*237	8.777	9	6	67 %
Woreda 5	1	1÷27*237	8.777	9	4	44 %
Woreda 9	2	2÷27*237	17.55	17	14	82 %
Woreda 10	2	2÷27*237	17.55	17	15	88 %
Woreda 4	4	4÷27*237	35.11	35	24	69 %
Total	27 poor drainage roads		Total 237 sample	Total 237 questionnaires distributed	Total 174 received 73.4%	

4.2 Respondent's Profile.

Table 9: Respondent's Profile

Demography variables.		Frequency	Percentage	Valid %
Respondent's Gender	Male	68	0.39	39%
	Female	106	0.609	61%
Respondent's age	15-19	------	-------	-----
	20-24	15	0.086	9%
	25-29	88	0.505	50%
	30-34	59	0.339	34%
	35-Above	12	0.068	7%
Education attainment of respondents	1-8 grade	19	0.109	11%
	High school graduate	16	0.091	9%
	Diploma	44	0.252	25%
	Degree	75	0.431	43%
	Post graduate	20	0.114	12%
How often you typically use *Kirkose* sub city Asphalt roads?	Frequently	87	0.5	50%
	Two times a day	56	0.321	32%
	4 up to 6 times a week	25	0.143	14%
	2 up to 4 times a month	6	0.034	4%
	I m not user	--------	--------	-------
	Do not know	--------	----------	-------

As indicated the above table the gender proportion of female respondents is 61% this is because of women have been in the frontline of most household socioeconomic activities. (Nyatsanza Taurai Davies et.al. 2016, p.92) commonly,

in Addis Ababa city street cleaners are women also women are participate in collection of solid wastes and drainage maintenance activities further more in most cases also in traditional culture tasks and responsibilities such as cooking food feeding cleaning, sanitation family health, laundry, and other related house hold activities were done by females, women are responsible for domestic work like shopping, cooking, cleaning, and childcare and wellbeing of their husbands (World bank, 1999). (Eugene Asia et.al. 2013, p.289)

The second reason was women were willing and cooperatives to respond the questionnaires also they give valuables information in addition to this the most part of maintenance will be performed by women.

Out of total figure of 174 participants, the large part of respondents about 50 % of the respondent between 25-29 years old and 34 % of the respondent between 30-34 years old. The remaining participant's between 20-24 years old and between 35 up to above in percentage 9% and 7% respectively.

In this study 84% of participant's were young age group. The range of age was between 25-34 ages.

The sample of the research included all level of educational status 43% of respondents attended degree program. 25% of participant's has diploma and 12% of respondents post graduate the remaining 11% and 9% attend elementary and high school respectively. This is because of some samples collect from city government executives & municipal service organs.

The majority 50% of participants were frequently or repeatedly used *Kirkos* sub city roads those respondents were closer to drainage problems and have more information about the causes of the poor drainage the remaining respondents uses the roads two times a day those were covered 32% those respondents have better information.

In general the respondents profile indicates that they know the problems of drainage closely and deeply in which they are victim of the problem and hence they are owners of the affairs which concerned with the affair directly and correct information would be able to acquire from them.

4.3. Concerned Municipal Organs

As the researcher shows on chapter two under conceptual framework, there are two independent variables where various executive organs of the administration have included under first independent variable and thus they are directly and indirectly concerned for drainage affairs, they are service providers as well, in addition to this, they are responsible to construct drainage, after constructing shall undertake periodic maintenance, caring, putting penalty against illegal persons, coordinating the community to participate either with wage, cash and knowledge in creating psychological ownership of the community, make transparent about their operation, besides lodge their job performance for evaluation for the community and make the community to have information periodically.

For executive organs 9 questions have lodged/enquired

1. In your *Woreda* there is a community Committee that is in charge of testing, cleaning and maintenance of drainage lines and manholes by opening their covers and closing covers and providing close monitoring in this respect?

Options	V	Fre.	Valid %	Mean	Std.Dev.
Yes	3	31	18%	1.82	0.71
No	2	80	46%		
Don't know	1	63	36%		

Has stated in page 51 of the theoretical and conceptual framework one among the theories the researcher has utilized is functionalism theory. According to functionalism, society is a system of interconnected parts that work together in harmony to maintain a state of balance and social equilibrium for the whole. For example, each of the social institutions contributes important function for the society this perspective based largely on the works of Herbert Spencer, Emile Durkheim, Talcott Parsons, and Robert Mertone. thus different experts and institutions identified internationally have stated the importance and benefit of the

existence of drainage committee in their different surveys and among the importance of the committee extends are:

- Shall control whether the timely maintenance programs are carried out according to the programs following them up.
- Shall confirm the soil taken out of the manholes is lifted from the surrounding and whether the manholes covers covered properly.
- Shall confirm whether the drainage line/system is correctly constructed after the rain falls and shall give information to the concerned.
- Shall ensure problems which can be maintained simply coordinating and convincing the residence are maintained by the volunteer participants with the list cost before imposing serious damage.
- Shall create awareness in the schools, institutions, religions based organizations, the public gathering sites.
- Shall control the rule violations to be happened easily and surrounding and shall carry out the like.

As the gathered data shows there are no drainage committees of the asphalt roads.

According to functionalist theory elements of society are functional if they contribute social stability and dysfunctional if they are disrupt social stability like loss of public assets stealing drainage manhole steel covers, disposing solid waste in the drainage manholes, linked sewerage with drainage,...etc.

Community participation is critical in drainage affairs. The community participates by maximizing limited government budget, also easily identifying and addressing the drainage problems. Drainage committee can at least monitor the functioning of the system and report defects and deficiencies to the officials responsible. Absent of community participation aggravate the drainage problem.

2. When Addis Ababa Roads Authority completes cleaning and maintenance works of drainage lines and drainage manholes on asphalt roads, what will it do with *Woreda* or utility offices of the *Woreda*?

Options	V	Fre.	Valid %	Mean	Std.Dev
Notify to the community and *Woreda* Offices in advance and upon completion of works	5	12	7%	2.8	1.11
Sometimes it notifies and hands over upon completion	4	20	12%		
Does not notify to the community and *Woreda* Offices in advance or upon completion of works either	3	99	57%		
Whether it notifies or hands over, there is no problem	2	6	3%		
Don't know	1	37	21%		

In the functionalism theory like human being physical body for instance hand, leg, eye, mouth, nose, tongue, Addis Ababa City Administration has established different executive bodies, these each executive parties established if bring not the desire result engaging efficient to their own task identifying apparently their roles and supporting and coordinated each other it is not possible to say the institutions have carried out tasks. To certify whether such executive bodies have correctly and timely carryout their tasks without non has intervene to the responsibility of the other, to handover responsibly calling for the handover as well to be certified with the task is carried out confident to the task it has accomplished, the one taking over must control and look after responsibly, is there any procedure which is transparent and accountable such government bodies engage in collaboration and coordination each other? According to the present procedure instead of identifying the source of the problem one executive body blaming the other executive body and the community it is considered they

have been disputing each other, when it blames the community and the community with its part blames the executive bodies.

As page 51 of the theoretical and conceptual framework is specifies one among the theories the researcher has utilized is the path goal theory of leadership whose modern development is attributed to Martin Evans and Robert House (1964), among these government bodies and nonobjective required to be lodged to the government the impediments happened and removing obstacles clearing the ways in order to furnish the desired service to the community it is the path goal theory of leadership which shows where the problem has happened and solve the same with understanding as well identifying the obstacle, where the problem has happened with the community by such government bodies? Where the gap is created? It is the objective of this study to avoid the problem when arriving to the spot where the problem is following the foot stapes of them. The path goal theory predicts the most effective leadership behavior based on a combination of followers characteristics and task characteristics. The approach suggests that a leader should choose a style that supports the need of the follower and fits the work they are doing in order for followers to best accomplish tasks. The leader must create a clear path for the followers to achieve goals or productivity by defining goals clarifying the path for the followers. This theory defines the role of a leader who defines the goal and lay down the path for the subordinates that facilitates completion of goals. Clarifies the task scope responsibility / boundary the role and responsibilities of the subordinate provides guidance and coaching remove obstacles that might affect the task completion and provide psychological support and rewards as way to complement the work environment.

As the data collected through questioner shows before and after maintenances were ensured by Addis Ababa City Road Authority which manages the roads as an owner the information confirms that whether it has carried out the task properly and it shall handover taking the responsibility calling for the same to be taken over requiring the same to be confirmed by the other party and body and the procedure is not transparent and carried out alone.

3. Executive bodies of *Kirkos* Sub-City and *Woreda's* administrations know about asphalt road shaving problems with drainage lines and drainage manholes in the *Woreda*?

Options	V	Fre	Valid %	Mean	Std.Dev
They know about the numbers and types of asphalts having problems	3	25	14%	2.1	0.45
They don't know about the numbers and types of asphalts having problems	2	137	79%		
Don't know	1	12	7%		

As on the page 51 of the theoretical and conceptual framework one among the theories the researcher has utilized is Piaget's theory of Cognitive development developed by Jean Piaget's (1896–1980) he is a Swiss developmental psychologists and philosopher. In Piaget's view, the development of knowledge is a form of adaptation and, as such involves, the interplay of two processes, Assimilation and Accommodation. Assimilation refers to the process by which an individual uses an existing structure or ability to deal with some problem in the environment. Accommodation is a process by which the individual must change in response to environmental demands. And what relate this study with this theory is the structure of the existing administrative executive body whether solves the problem of the community as defined under the statement of the problem? Or is new structure required? Taking such two alternatives it attempts to solve the problem, if the government executive bodies carries out their tasks alone and they shall not coordinate and collaborate having each other's information as well understanding and evaluation each other's information it is not possible to care for the law violation and the public health and property stated under the statement of the problem.

As the gather data exhibits the information show that the *Woreda* have no knowledge about the damaged drainage and maintenance programs.

4. Let residents of the *Woreda* participate in drainage line and drainage manhole testing cleaning and maintenance activities to ensure their sense of their ownership as they are also vulnerable victims?

Options	V	Fre	Valid %	Mean	Std.Dev
They can't because it requires special skills.	2	12	7%	3.80	1.10
They are not willing because of poor work culture	3	49	28%		
They cause delayance in performance of works	4	46	26%		
There is no one to motivate and coordinate community	5	60	35%		
Don't know	1	7	4%		

The community discussing based upon the confidence and interest as well willingness on the case, litigating with the spirit of becomingness moving about widely through its labor, money resources and goods and according to the participation instead of the solving the problems it has been the cause of the problems and the victim of the problem the reason for enabling to establish the drainage committee helping the community solve its own problems is since there is no party to organize the community and they cannot solve their problems establishing committee.

5. Persons who blocked drainage lines and drainage manholes by putting in solid waste and linked sewerage lines with drainage lines were arrested and penalized by Code Enforcement Officers because?

Options	V	Fre	Valid %	Mean	Std.Dev
Not to pay service fees	2	-	-	4.34	1.03
They have no access to solid waste disposal and sewerage disposal services in time	3	44	25%		
Negative acts	4	6	4%		
Of negligence and deliberate act	5	119	68%		
Don't know	1	5	3%		

In order to know what are the causes which motivates the residents violate the rules and since it is important to rich solutions for the problem it is the question lodged to understand the residence are violating rules whether understanding that they shall be penalized to their conscience or for the cause which is accidentally out of the control of their taught and control, the data gathered shows they carry out the mistake of violating rules with negligence willingly.

6. Addis Ababa City Roads Authority blocked drainage lines and drainage manholes while cleaning these mainly because?

Options	V	Fre	Valid %	Mean	Std.Dev
Latrine sewerage deposits	2	6	3%	4.16	1.08
They are blocked by household solid waste	3	12	7%		
Plastic water packaging bottles and plastic products	4	63	36%		
These are blocked by dust	5	83	48%		
Don't know	1	10	6%		

As specified on page 52 the key variables the two independent variables among those directly or indirectly concerned with the case which are Addis Ababa City Road Authority and Addis Ababa Cleanliness Administration Agency since they understand the reason behind most of the times it is closed in the drainage maintenance as well the Addis Ababa Cleanliness Administration agency workers which cleans the road once and twice a day more than any one extend the clue and information they observe and understand the researcher has an interview with them.

As the researcher has considered and as attached in page 114 (See Annexes) of this research taking photograph for the purpose of evidence it has considered soil filled in the manholes and ejected from it but it has considered the both side ditches have no much soil inside them and they are open it has interviewed the surrounding gathered communities and the two municipal organs subordinate and the sub city heads to know the cause requiring how such huge amount of soil can be found from the brims of the manholes? And received different responses.

- Since the manholes are not covered properly, it is cleared every time and such garbage's dusts are poured in to the manholes and they care not why giving only attention for its cleanliness but not soils are dumped into the manholes.
- After the drainage maintenance employees extract the soil form the manholes the leave heaving besides the manholes and without picking by the vehicle and it is eroded and slipped into the manholes with the rain.
- The dump trucks transporting the construction soil beyond their capacities shall move spilling over, no one controls them in the night, though it is illegal act even some traffic polices with the thought not to hinder the development they keep their silence the spilled over soil shall be flooded to the manholes.
- The Addis Ababa Cleanliness Administration agency in its part has

affirmed that the responsibility of picking the spilled over soil is not of them we sweep dry garbage but we shall not pick soil.

The reasons are this, under question Sr. No. 9 the Addis Ababa Cleanliness Administration Workers clearing the road one and twice a day under question Sr. No. 6 have responded similarly for the question lodged and the drainage system is blocked mostly showed by the information by the plastic water package bottles and dust, practically the photo taken by the researcher certifies the information to be fact. (See Annexes)

7. Drainage line manholes without cover in Sub-City are not properly closed, and in some cases the surface of the asphalt and cover are stucked because?

Options	V	Fre	Valid %	Mean	Std.Dev
Policy problem	2	6	3%	4.22	0.90
There is no one to provide close monitoring and inspection on the road with a sense of ownership after maintenance	3	37	21%		
There is no appropriate maintenance	4	44	26%		
There is a gap between users and owner of the road.	5	87	50%		
Don’t know					

As the researcher has observed moving about and as attached through the photograph evidence (See Annexes) on behalf of the beneficiary community and since there is a gap with Addis Ababa City Road Authority managing the road as an owner under by Regulation No 7 and 1998 Proclamation since there is no timely maintenance as well since there is no controlling party following closely with the spirit of belongings after maintenance the information shows such facts.

8. The task of control of violations on drainage lines and drainage manholes is very difficult for Code Enforcement Officers?

Options	V	Fre	Valid %	Mean	Std.Dev
Residents are not cooperative as tippers	2	4	2%	4.18	0.88
There is lack of awareness about violations of regulations	3	31	18%		
Violations are committed out of normal work hours of Code Enforcement Officers	4	60	35%		
There is no sense of ownership on the part of residents	5	77	44%		
Don't know	1	2	1%		

As the human being reserves human and democratic rights the roads also have right vested through the law and the all the community must observe, any individual violated the rules of the road conscious or unconscious shall be penalized of different penalties as the level of the offence.

Illegal tasks are enacted in detail under Code No. 2 / 2003 to get the rights observed and among such rights willingly connect the sewerage and the drainage committing violations connection with the drainage system, to flash out drainages, to construct over the drainage system and manholes, to fence, to open their covers, to still, to dump dry garbage, to stink mud, to break rock to pour soil, to line up rock, to spill over soil for lack of covering the same while loading it, to park non-functioning car, to wash vehicle on the road … the like illegal activities are in detail provided with the penalties. To control this and other violations the office of code enforcement service under Proclamation No. 37 / 2013 is established. However as stated under the statement of the problem the resident that been penalized though the court and the law enforcers and sustaining damage and loss to their health and activities and the government expenses have been excavated. As the data gathered shows the cause for this

has not created physiological ownership to the community and since the activities are carried out outside the law enforcement working out.

9. Main findings during cleaning of main roads by *Kirkos* Sub-City Sanitation Administration are?

Options	V	Fre	Valid %	Mean	Std.Dev
Household solid waste	2	7	4%	3.95	0.97
Litters left around by illegal roadside traders	3	37	21%		
Plastic water packaging materials	4	68	39%		
Dust collections	5	57	33%		
Don't know	1	5	3%		

Mostly the plastic water package bottles and dust collected in the time of cleaning this evidence is in performance with what is specified under question No. 6. The evidence secured from two distinct administrative organs is showed similar. As the researcher has turned around to visit when maintenance was carried out and as in page 114 attached evidence photo. (See Annexes) mostly drainage system is closed and it has confirmed types of garbage found while swiping the road is similar.

Whereas among the (9) requisition submitted to the municipal organs maximum mean is 4.34 and the minimum mean is 1.82.The maximum mean is 4.34, those who contacted the liquid waste of latrine withy drainage thereby closed drainage in putting solid waste; who theft cover of the manhole, previously sustained damage whereof penalized in knowing their reason with gross negligence and carelessly. The collected data has shown that they did not forecast result of their action. Whereas, the highest mean 4.22 the drainage system of the sub city do not cover some of the manhole, some of them not joined/aligned correctly as well as since some of the inlet have fixed with the asphalt which do not allow water to pass in and few of them have closed with water packaging plastic, having gap between owner of the road and residents as well as not conducting

maintenance with registered information in moderate method thereby executive organs do not work in integrated manner as consistent data/mean shows.
As the third existing data shows, due to the absence of felling of psychological ownership of residents that makes difficult to monitoring breach of code for drainage lay the code enforcement officer that become a reason for difficulty such problems. The least mean are from 1.82 up to 3.0 the data has shown that there is no drainage committee within the *Woreda's* located in the Sub City thereby do not known and have information whether the Addis Ababa Road Authority conducted maintenance or not as well as here is no follow up, monitoring and handling over system through executive organs and community after maintenance and do not know program as well as show much poor drainage exist.

The information collected from maintenance and road cleaners shows that when they cleaning drainage they always find that plastic packaging water, dust and the like when the Addis Ababa Road Authority and Cleanliness Administration Agency opening the closed drainage.

The highest standard deviation 1.11 indicated that Addis Ababa Road Authority Does not notify to the community and *Woreda's* Offices in advance or upon completion of works either.

4.4. Community

About 17 questions have lodged to the community over problems in awareness and participation pertaining to the problems on side of the community such as contracting liquid waste of latrine with drainage, opening and theft of manhole cover, closing, adding solid waste and the like on basis of the baseline survey/reaches and as statement of the problem mentioned hereto.

1. The community has been performing either with their money or material to resolve problems of the manholes that having rain stagnant water, manholes do not cover properly which disturb movement of the community?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	88	51%	4.24	0.92
Agree	4	53	30%		
Undecided	3	20	12%		
Disagree	2	13	7%		
Strongly Disagree	1				

Infrastructures shall be developed when the public are widely engaged and when the government moves about to close the wholes which cannot be covered by the public and it is apparent from any one it is an activity organized by the two. The community ensuring participation based upon confidence and interest it is evident through the information secured from this request that the community have the desired to solve the drainage problems disturbing its activities and health and most of the residence support the participation.

2. The community has immediately resolve problems when they observe poor drainage mark before sustaining gross damage?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	101	58%	4.6	0.49
Agree	4	73	42%		
Undecided	3				
Disagree	2				
Strongly Disagree	1				

The community understands where the problem lies concerns the drainage problem of the surrounding most of them have agreed the problems must be easily maintained upon symptoms are considered with the spirit of ownership without expecting the action of other parties.

3. After rain, the community has exchanging information with concerned organs pertaining to the proper function of the drainage manhole after observing the same?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	126	72%	4.7	0.44
Agree	4	48	28%		
Undecided	3				
Disagree	2				
Strongly Disagree	1				

If there is a party receiving evidence the study shows the community is willing to give the concerned evidence after the rainfalls, where water has break forth and move to Asphalt and the road of pedestrians, where the water originates, which has not let water inside and lets the water the community is ready to give evidence accordingly.

4. The community has participated in providing information during maintenance activities and participated in monitoring activities after maintenance conducted?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	94	54%	4.41	0.69
Agree	4	59	34%		
Undecided	3	21	12%		
Disagree	2				
Strongly Disagree	1				

The maintenance workers in order to control their procedures in the time of maintenance whether soil are properly extracted from the manholes, to control the personnel engaged have properly covered the manholes picking the extracted soils from the surrounding the evidence collected has confirmed the

necessity of such type of control and handover and that the community is willing to control the same.

5. The community has know period of drainage system maintenance in the surrounding, have maintained adequate information that signed by heads thereby made to clean and monitoring as per the program?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	96	55%	4.36	0.77
Agree	4	46	26%		
Undecided	3	32	19%		
Disagree	2				
Strongly Disagree	1				

The information shows when the drainage of the *Woreda* are maintained how many times a year and cleaned since understand the programs the residents have agreed to maintain written evidence to ensure the timely maintenance to be carried out according to the program.

6. The road and drainage work needs higher cost. Outside Road fund paid for the road by the community, has been closely monitoring over drainage system in voluntary?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	93	54%	4.39	0.72
Agree	4	56	32%		
Undecided	3	25	14%		
Disagree	2				
Strongly Disagree	1				

.

The vehicle owners are recalled to settle Road fund payments according to their capacities, the one get hurt physically and in health seriously are the pedestrian

and residents on the street sides the information gathered has showed they are consensual to participate voluntarily on the drainage case.

7. Making that community in assessing and evaluating executive organs that assigned by the administration towards affairs of drainage periodically?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	81	46%	4.28	0.75
Agree	4	62	36%		
Undecided	3	31	18%		
Disagree	2				
Strongly Disagree	1				

The community extracting and understanding the rights information with the transparent and accountable principle concerns the procedures of executive bodies the information shows residents are in favor of the assessment and evaluation by the residence lodging the problems face every time and results where they are properly carried out.

8. The problems that occur during maintenance period wage, cash and material have resolved along with the community and support?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	25	14%	3.32	1.06
Agree	4	55	32%		
Undecided	3	52	30%		
Disagree	2	36	21%		
Strongly Disagree	1	6	3%		

Most of the residents agreed in participating to help the maintenance workers resolving the material, labor, and money problems faced extending information in collaboration with the maintenance workers in the time maintenance.

9. Beyond decreasing cost for maintenance since the *Woreda* and community have responsibly performed that upgrade awareness of the community?

Options	V	Frequency	Valid %	Mean	Std.Dev
Strongly Agree.	5	122	70%	4.7	0.45
Agree	4	52	30%		
Undecided	3				
Disagree	2				
Strongly Disagree	1				

When the blocked drainages are cleared the resident together with the maintenance workers in person the action of sweeping the locking garbage while extracting the same beyond deducting expenses the crimes carried out violating the rules how much they hurt the community beyond increasing the awareness of the residents the information secured shows it shall ensure the community to care and protect for its properties concerns the manholes of the surrounding instead of ignoring when garbage are let into the drainage man whole.

10. Where solid waste is not collected in time, it might cause health hazard; thus it should be disposed away from residential areas?

Options	V	Fre	Valid %	Mean	Std.Dev
Absolutely agree	4	95	55%	3.27	0.96
Agree	3	47	27%		
Somehow agree	2	16	9%		
Disagree	1	16	9%		
Don’t know					

As the researcher looks and as stated in page 115 in the research with the photograph taken if the community gets not the dry garbage picking service instead of requiring bodies concerned the information secured shows it shall discard the way conducive acting as a pedestrian in any opportunity secured and

this thought is inside the residence and there are residence retaining heritage for the dry garbage.

11. The practice of disposing solid waste in a concealed hole located in a place that suits easy visibility?

Options	V	Fre	Valid %	Mean	Std.Dev
Absolutely accepted	1	46	26%	2.26	1.05
Accepted	2	69	40%		
May be somehow accepted or not accepted	3	26	15%		
Disagree	4	33	19%		
Don't know					

The information secured shows the residence throwaway dry garbage to the open manholes (uncovered manholes, holes, open ditches) and they prefer to discard to the open manholes or open ditches instead of putting dry garbage in the way observed.

12. The use of rainwater is that it washes away all waste?

Options	V	Fre	Valid %	Mean	Std.Dev
Absolutely agree	1	32	18%	2.27	0.75
Agree	2	62	36%		
Somehow agree	3	80	46%		
Disagree					
Don't know					

The information gathered shows there is the taught in the community the rain fall shall wash away dry garbage for this reason when torrential rains are fallen down as the researcher has observe there are individuals release sewerage as well dead domestic animals and dry garbage. Information shows there are lack of awareness that the dry garbage pollute the water which is used as irrigation and limits its movement.

13. Sewerage waste, rain water waste and solid waste are all similar?

Options	V	Fre	Valid %	Mean	Std.Dev
Agree	2	31	18%	2.64	0.64
Disagree	3	127	73%		
Don't Know	1	16	9%		

The information gathered has showed most of residence identify differ bulk and dry garbage but the information do not show whether the community identified or not why such dry and bulk garbage are utilized.

14. Rainwater flow on pedestrian and asphalt roads?

Options	V	Fre	Valid %	Mean	Std.Dev
Because of high rainfall	2	33	19%	2.72	075
Because drainage lines are blocked	3	109	63%		
Because drainage manholes do not allow rainwater to flow in	4	16	9%		
Don't know	1	16	9%		

As the gathered information shows the community believes floods are over flooding asphalt only for torrential rains are follow down but not the road has manholes problem.

15. Drainage lines and roads are owned by government?

Options	V	Fre	Valid %	Mean	Std.Dev
Yes they are	1	32	18%	1.82	0.39
The owner is the beneficiary people	2	142	82%		
Don't know					

As the evidence secured shows according to the knowledge and information

level the community does think draining utility is the public asset. But this information doesn't show whether physiological ownership is not created.

Study show that felling of owner ship or psychological owner ship more important in administration of public assets. Feelings of ownership help to create positive attitude, self-concept and Sense of responsibility.

Positive attitudes

The psychology of possession literature demonstrates that people feel positively In other words, feelings of psychological ownership lead to positive attitudes about the entity (Nuttin, 1987). (Linn van dyne and Jon l. Pierce, 2004, p.441)

Self-concept

The psychology of possession also proposes that feelings of ownership cause people to view tangible and intangible possessions as part of the extended self (Belk, 1988; Dittmar, 1992; Furby, 1978). For example, James (1890) linked 'mine' and 'me': 'We feel and act about certain things that are ours very much as we feel and act about ourselves' (p. 291). (Linn van dyne and Jon l. Pierce, 2004, p.441)

Sense of responsibility

According to Beaglehole (1932) and Furby (1978), possessions and feelings of ownership trigger a sense of responsibility for the entity. For example, Hall (1966) argued that possession causes individuals to protect and defend their ownership rights. The property rights literature also emphasizes protecting and enhancing possessions (Wilpert, 1991). This includes improvements and controlling or limiting access by others. (Linn van dyne and Jon l. Pierce, 2004, p.441)

16. Opening cover, testing, cleaning and maintenance of drainage lines and drainage manholes, closing them in a reliable manner and making close monitoring?

Options	V	Fre	Valid %	Mean	Std.Dev
Requires special skill	2	87	50%	1.92	0.70
Does not require special skill	3	37	21%		
Don't know	1	50	29%		

Information gathered shows the community and the government executive bodies do think the drainage maintenance task requires special profession, some requested can be referred that they have no knowledge. It is possible to understand there is the knowledge gap with the literates. But the fact has stated under the research of the researchers it is ordinary work requiring not special profession, some countries as information shows engage residence with the lowest endowment to crate job opportunity. (Howard, 2002) (Dr. Jonathan Parkinson, 2003, p.125)

17. Do you have detailed information on the types of penalties punishable on violation of codes?

Options	V	Fre	Valid %	Mean	Std.Dev
Yes I do absolutely	5	41	24%	3.34	1.17
I know	4	28	16%		
I don't know exactly what is punishable and what is not	3	65	37%		
Don't know anything at all	2	30	17%		
Undecided	1	10	6%		

They have responded not observing road rights and violating the same shall make liable, most of residence do not properly understand the extent of the penalty and the information they have when answering the questions they are lodged.

Whereas, the maximum mean is 4.7 and minimum mean is 1.82.the highest mean 4.7 indicate they have demonstrated willingness to take care, to make voluntary participation with integrity with their wage to resolve such problems in relation to the poor drainage that disturb day today activities of the community having maximum mean from 4.24 - 4.7 that are not covered correctly that found around the residence which releasing liquid waste to latrine, to observe that

correctly functioning with concerned organ, to know maintenance program, to monitoring maintenance as per the program.

The data has shown that solid wastes that do not collect on time through the community shall dispose in a way that considered proper within. The minimum mean from 1.82 to 3.27 Furthermore, given to wrong attitude and hate to solid waste instead of putting on free place they put on manhole or ditch as shown the data this kind of process is lack of awareness to appropriately dispose such solid waste that may bring the worst problem.

Furthermore either the executive organ of Administration or residents that lodged with question majority of them thereby believe that maintenance of drainage required special skill; to the fact that in opening and cleaning manhole as well as covering the manhole in correct way and in monitoring and making get maintenance having information as per the program does not required special skill. (Howard, 2002) (Dr. Jonathan Parkinson, 2003, p.125)

The response for questions within minimum mean over the issue shows that most of respondents/residents do not have lack of awareness. However they consider that water from rain shall take such solid waste or liquid waste; the data has also shown that they do not have adequate information in breaching code that limited with code enforcement service.

The highest standard deviation is 1.17 the result show they have no detailed information on the types of penalties punishable on violation of codes.

4.5. The Participant's Response on Open-Ended Questions

Out of total figure of 174 participants only 96 or 55% of respondents respond their opinion to open-ended question in their own word the cause of the problem with drainage manholes of asphalt roads in the Sub City.

Limited capacity and resources like finance technology the drain and the manholes are not located in the right place and in the right distance. There is no proper inspection system. The inlet of the manholes not considered the

community life style. There is no systematically arranged data. There is lack of coordination in the city government executives & municipal service organs. Also there is lack of motivation in government executives & municipals service organs. Lack of coordination in drainage maintenance lack of proper waste management system insufficient capacity of drainage structures Lack of awareness and misuse the drainage in the community side also they are not segregated liquid wastes with solid wastes Lack of regular solid waste disposal lack of proper design The community was not monitoring and supervising the drainage maintenance task. Back ward life style lack of sound policy lack of clarity in owner ship lack of inspection. Users of plastic bags and plastic water bottles became increased day to day. Different codes and procedures in code enforcement service blocking the flow of water in the manhole systems are illegal acts but sewerage and liquid wastes are different in codes and procedures. The city administration not coordinated. Orphan Children's and informal business street traders filled up the drainage by throwing plastic water bottles. Dump truck drivers and construction enterprises also some traffic polices not cooperated as the result the existing infrastructure became demolished and blocked by soils.

4.6. Respondent's Response on Unstructured Interviews

Addis Ababa City Road Authority does not notify to the community and *Woreda's* Offices in advance or upon completion of works either. No one received the maintained drainage in the community or in the sub city side and there is no a community Committee that is in charge of testing, cleaning and maintenance of drainage lines and manholes by opening their covers and closing covers and providing close monitoring in this respect. In the city administration level there were absence of coordination and collaboration. Some municipal service organs need focus group discussion to each other and within the community.

4.7. Observations

As per observation of the researcher in moving to *Woreda's* under sub city which the drainage located in as well as captured photograph and attached hereto for

evidence,(See Annexes) the researcher have able to observe that during raining period such water never pass through the drainage rather running over road of pedestrian and highway some manholes are not covered and thus since the manhole does have resembles with the road during night time some elders or sophisticated persons, blind have collided and entered into whereby sustained injury as well as manholes do not covered appropriately and are difficult to the pedestrian. Besides, the researcher can observe that liquid waste of latrine contacted with drainage as well as during maintenance of drainage huge amount of waste collected.

As per observation the researcher some individuals have pouring down urine, adding dead domestic animal to manhole, some youth have entering plastic in playing as ball to manhole, as well as urination in side manhole, anything shall throw over any open wall, house made that finalized daily house hold chorus have pulling solid waste about 9-11 PM in the evening and abandoning on the open road or ditch or manhole.

4.8. Conclusion

The information with collected with various technique replies fundamental question of the research. The information shows that there is no modern maintenance system, executive organ of the administration have separately perform participating the community/resident, there is no higher lack of awareness for problems that have been conducting on side of the community and the code breached with gross carelessness and negligence.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

The road coverage of Addis Ababa has been upgrading with higher speed, new roads have been under construction as well as horizontal wide area have has been increasing time to time as well as population number increasing. The Asphalt road coverage reached more than 2600 kilometers by 7 meter width. The study investigated that the challenges of sewerage and drainage maintenance management in Addis Ababa city administration in the case of *Kirkos* sub city. The study assessed the management aspect in post construction stage.

Results which acquired from the research

- There is no result oriented maintenance system that supported with correct information and program without participation and integration of executive organs and residents.

- Whereas the poor drainage problem has been committing with negligence of residents, that become difficult to monitor is also psychological ownership have never installed within residents.

- The poor drainage problems which have been observing within the sub city is due to the an integrated operation pertaining to the manholes that do not cover properly as well as do not have cover which closed by solid waste and water packaging plastic as well as period of maintenance is not known by residents as well as executive organs of the *Woreda* and the residents do not have participate during maintenance period, they do not know whether maintenance have conducted or not.
- They breaching the code in knowing that due to the psychological ownership do not created within the community. Although the community needs to participate voluntary in deeming that problem to resolve easily which disturb their day to day activities in relation to problems to the

drainage, there is no one who tries to integrate them. In general, there is no creation of organization that initiates, coordinate and integrate.

Therefore, this study forwarded the following recommendations

- After constructing roads, when marks seen that required focused and monitoring and drainage in which recording information as it is mandatory to immediately repairing as well as it needs monitoring that has maintained as per the program and thus the maintenance works that may repaired with small cost shall be maintained/repaired by the *Woreda's.* This way simplify burden of the Addis Ababa Roads Authority as well as makes to better construct in providing focus team new roads. In monitoring the close by *Woreda's* ownership sprit in maintaining before occurrence of huge damage that increases age of the road and makes to decrease cost of the government.
- Participation of the community during maintenance practically may understand the problem deeply, enabling to care under filling of ownership, become responsible, proving focus to problems, able to stop when the code breached, support them to prevent as well as upgrading their awareness.

Bibliography

Addis Ababa city road authority, (2016) Fnote Addis edition 9 number 6 May 2016 Addis Ababa

Addis Ababa city road authority, (2015) Fnote Addis edition 7 number 2 January 2015 Addis Ababa

Addis Ababa city road authority, (2015) Fnote Addis edition 9 number 5 May 2015 Addis Ababa

Addis Ababa city road authority, (2015) Year book December 2015 Addis Ababa

Addis Ababa city road authority, (2014) Fnote Addis Special edition March 2014 Addis Ababa

Addis Ababa city road authority, (2011) Fnote Addis number 6 January 2011 Addis Ababa.

Addis Ababa city road authority, (2016) Zena Meneged edition 1 number 3 Addis Ababa.

Agbonkhese Onoyan-usin, Yisa Godwin Lazhi, & Daudu Paul Itomi-ushi. (2013). Bad Drainage and Its Effects on Road Pavement Conditions in Nigeria. Civil and Environmental Research, 3(1), 7-15.

Asia Foundation (2008) Road and drainage maintenance Ministry of local government and provincial councils Transparent Accountable Local Governance Sri Lanka

Austin Otegbulu,(2011) Economic Valuation of Poor Road Infrastructure Lagos: A Focus on Urban Households Global Journal of HUMAN SOCIAL SCIENCE Volume 11 Issue 10 Global Journals Inc. USA

Balmér, P. (2001). Possibilities to improve the quality of wastewater sludges. Water Science and Technology, 44(10), 19-26.

Bath&NorthEastsomersetcouncil(2016).Highwaysdrainage.http://www.bathnes.gov.uk/services/streets-and-highway-maintenance/drains

Belk, R. W. (1988). Possessions and the extended self. Consumer Research, 15, 139–168.

Bennet EB. (1998).Public-private Cooperation in the Delivery of Urban Infrastructure Services (Water and Waste), Yale-United Nations Development Program-Public Private Partnerships (UNDP-PPP).

Benevolo, L. (2001). História da Cidade, Editora Perspectiva, São Paulo, Brazil

Beverley Hancock, Elizabeth Ockleford & Kate WindridgeAn(2009) Introduction to Qualitative Research The NIHR Research Design Service for Yorkshire & the Humber Division of Primary Care, 14th Floor, Tower building University of Nottingham University Park Nottingham

Boller, M. (1997). Tracking heavy metals reveals sustainability deficits of urban drainage systems. Water Science and Technology, 35(9), 77-87.

Brown, R.R., Farrelly, M M.A and Keath, N. 2007. Perceptions of Institutional Drivers and Barriers to Sustainable Urban Water Management in Australia. Report No.07/06. December 2007. National Urban Water Governance Program, Monash University, Australia. ISBN 9780980429824.

Burian, S.J. & Edwards, F.G. (2002). Historical perspectives of urban drainage, Global Solutions for Urban Drainage, Proceedings of the 9th International Conference on Urban Drainage, Portland, September 2002.

Butler, D. and Davis, J. W. (2004). Urban Drainage (Second .Ed.). Spon Press, London

Canholi, A.P. (2005). Drenagem urbana e controle de enchentes, Oficina de Textos, ISBN 8586238430, São Paulo, Brazil

Cairncross, S and E AR Ouano (1991), Surface Water Drainage for Low-income Communities, WHO/UNEP, World Health Organization, Geneva, Switzerland

Carley, M, P Jenkins and H Smith (editors) (2001), Urban Development and Civil Society: The Role of Communities in Sustainable Cities, Earthscan, London.

Chocat, B., Krebs, P., Marsalek, J., Rauch, W. & Schilling W. (2001). Urban Drainage Redefined: from Stormwater Removal to Integrated Management. Water Science and Technology, Vol. 43, No. 5, (2001), pp. (61–68).

Chris Hoban John Riverson & Albert Weckerle (1994) Rural Road Maintenance And Improvement environmentally Sustainable Development Staff Transportation, Water & Urban Development Department Transport Division Report TWU 11WORLD BANK

C. Michael Lee, (2016) Maintenance Management Manual Texas department ofTransportaton

Cotton, AP, M Sohail and W K Tayler (1998), “Community initiatives in urban infrastructure”,Water, Engineering and Development Centre, Loughborough University,UK. C,R,Kothari, (2004) Research Methodology Methods and Techniques 2nd edition New Delhi

D'Arcy, B. & Frost, A. (2001). The role of best management practices in alleviating water quality problems associated with diffuse pollution. The Science of the total environment, 265(1-3), 359-367.

David O. Olukanni, Rachael A. Adebayo, Imokhai T. Tenebe, (2014) Assessment of Urban Drainage and Sanitation Challenges in Nigeria International Journal of Emerging Technology and Advanced Engineering Volume 4, Issue 12, Ota, Ogun State, Nigeria

Dittmar, H. (1992). The social psychology of material possessions: To have is to be. New York: St. Martin Press.

Dr. Jonathan Parkinson, (2003) Drainage and storm water management strategies for low-income urban communities .Environment & Urbanization Vol 15 No 2 October 2003 Brazil

Dr. Jonathan Parkinson, (2013) Drainage and storm water management strategies for low-income urban communities' .Environment & Urbanization a journal, published part 2 by SAGE in association with IIED (International Institute for Environment and Development)

Dr. R. R.Singh, Er.Navpreet Kaur, & Er.Nitin Goyal (2014) DRAINAGE ON ROADS International Journal Of Progresses In Civil Engineering volume-1,issue-1PEC University of Technology,Chandigarh, INDIA

Ellis, J.B., L Scholes and Dm Revitt. 2009 Evaluation of Decision making Processes In Urban Storm water Management TASK 2.2.3a. March, 2009. EU 6th Framework SWITCH Project, Sustainable Water Management in the City of the Future. www.switchurbanwater.eu

Eugene Asia Günter Buschb and Lilian Nkengla (2013) The Evolving Role of Women in Sustainable Waste Management in Developing Countries- A Proactive Perspective? International Conference on Integrated Waste Management and Green Energy Engineering (ICIWMGEE'2013) April 15-16, 2013 Johannesburg (South Africa)

Furby, L. (1978). Possession in humans: an exploratory study of its meaning and motivation. Social Behavior and Personality, 6, 49–65.

Geoffrey, M, David, D, David, F, 2005 Essentials of Research Design and Methodology New Jersey

Glenn D. Israel (1992) Determining Sample Size. Florida Coperative extension servies Institute of Food and Agricultural Sciences, University of Florida. Publication date: November 1992 Universty of Floreda

Hall, E. T. (1966). The hidden dimension. Garden City, NY: Doubleday

Hatt, B. E., Fletcher, T. D., Walsh, C. J. and Taylor, S. L. (2004). The influence of urban density and drainage infrastructure on the concentrations and loads of pollutants in small streams. Environmental Management, 34(1), 112-124.

Henry Flagg French (2007) Farm Drainage C.M Saxton, Barkers & Co, Agricultural book publishers No 25 park row NEW YORK

Howard, G, C Bogh, G Goldstein, J Morgan, R Shaw and J Teuton (2002), Healthy Villages: a Guide for Communities and Community Health Workers, WHO, Geneva.

Imparato, I and J Ruster (2003), “Slum upgrading and participation”, World Bank, Washington DC,USA.

Jitendra, G., Pradeep, K. A. and Manoj, K. S. (2013). A Framework for quantification of effect of drainage quality on structural and functional performance of pavement. International Journal of Engineering Research. Volume No.2, Issue No. 3, pp : 257-263

J Patrick H Arampamoorthy, G Arnold (2014) Optimizing drainage maintenance for pavement performance NZ Transport Agency research report Wellington 6141, New Zealand

Jukka Isotalo (1992) Community Participation in Rural Road Maintenance: Finnish Experience and Lessons for Sub-Saharan Africa Transportation,

Water and Urban Development Department Transport No. Rd-13the World Bank

James, W. (1890/1950/1963). Principles of psychology. New York: Macmillan

John W. Creswell, (2014) Research Design Qualitative Quantitative Mixed Method Approach 4th edition Printed in the United States of America

Jone, W. Creswell (2009) Research Design Qualitative Quantitative Mixed Method Approach 3rd edition New Delhi

Kolsky, P (1999), "Engineers and urban malaria: part of the solution, or part of the problem?" Environment and Urbanization Vol 11, No 1, April,

Lammerink, M P and E Bolt (2002), "Supporting community management a manual for training in community management in the water and sanitation sector", Occasional Paper Series OP 34 E IRC, International Water and Sanitation Centre, Delft/Haarlem, the Netherlands.

Lawless,P(1996). The Linear City: Towards a new Agenda. Town Planning Review 167(1): 24 – 43

Linn van dyne and Jon l. Pierce 2004 Psychological ownership and feelings of possession: three field studies predicting employee attitudes and organizational citizenship behavior Journal of Organizational Behavior J. Organiz. Behav. 25, 439–459 (2004) Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/job.249 U.S.A.

Macro International Inc. "2008. Ethiopia Atlas of Key Demographic and Health Indicators, 2005." (Calverton: Macro International, 2008), pp. 2, 3, 10 (accessed 30 September 2010)

Magdi M. E. Zumrawi. (2016). Investigating Surface Drainage Problem of Roads in Khartoum State. International Journal of Civil Engineering and Technology (IJCIET), 7(3) 91-103.

Marcelo Gomes Miguez, Aline Pires Veról and Paulo Roberto Ferreira Carneiro (2012). Sustainable Drainage Systems: An Integrated Approach, Combining Hydraulic Engineering Design, Urban Land Control and River Revitalization Aspects Federal University of Rio de Janeiro Brazil

Marsalek, J., Rochfort, Q., Mayer, T., Servos, M., Dutka, B. and Brownlee, B. (1999b).Toxicity testing for controlling urban wet-weather pollution: advantages and Limitations. Urban Water, 1(1), 91-103.

Marshall, C.,& Rossman, G. B. (2006). Designing qualitative research (4th ed.). Thousand Oaks,CA: Sage.

Merriam, S. B. (1998). Qualitative research and case study applications in education. SanFrancisco: Jossey-Bass.

M. Coughlan and George W. Greenwood, (2007) The Importance of Drainage On Local Roads UNH Technology Transfer Center A Cooperative Effort to Assist New Hampshire Towns with Local Transportation Issues Arizona

Mitchell, B. (2002) Resource and Environmental Management (New York: Prentice Hall).

Mr.Dipanjan Mukherjee (2014) Highway Surface Drainage System & Problems of Water Logging In Road Section The International Journal Of Engineering And Science (IJES) Volume 3 Issue 11B.Tech in Civil Engineering West Bengal University of Technology; West Bengal, India

Mr. Ger Finn, et.al (2004) Guidelines for road drainage The Department of the Environment, Heritage and Local Government Ireland

New York City Department of Environmental Protection. (2012) Guidelines for the Design and Construction of Storm water Management Systems. Department of Buildings. Bureaus of Water and Sewer Operations and Environmental Planning and Analysis, and Office of Green Infrastructure .New York

Nuttin, J. M. Jr. (1987). Affective consequences of mere ownership: the name letter effect in twelve European languages. European Journal of Social Psychology, 17, 381–402

Palm, V. and Östlund, C. (1996). Lead and zinc flows from technosphere to biosphere in a city region. Science of the Total Environment, 192(1), 95-109.

PatilAbhijit, &PatilJalindar. (2011). Effects of Bad Drainage on Roads. Civil and Environmental Research, 1(1), 1-7.

Panayotou, T (1998). The Role of the Private Sector in Sustainable Infrastructure Development. Bridges to Sustainable Bulletin 101 UNDP.

Peter Migosi.(2014) Effects of Urban Storm water Management Strategy in Reducing Flooding; a Case of Mombasa International Journal of Managerial Studies and Research (IJMSR) Volume 2, Issue 4

Sadia Jabeen, Qaisar Mahmood, Sumbal Tariq, Bahadar Nawab, Noor Elahi Health (2011) Impact Caused By Poor Water and Sanitation In District Abbottabad Department of Environmental Sciences, COMSATS Institute of Information Technology, Abbottabad, Department of Pharmacology, Ayub Medical College, Abbottabad, Pakistan

Salim Momtaz (2006) Public Participation and Community Involvement in Environmental And Social Impact Assessment In Developing Countries International journal of environmental, cultural, economic and social sustainability Melbourne Common Ground Publishing Pty Ltd Australia

Sewagegn Terefe (2016) Assessment of Existing Road Storm Drainage System in the case of Shiromeda Kidanmeheret Road. Addis Ababa university institute of technology school of civil and environmental engineering

Silveira, A. L. L., Goldenfum, J. A. and Fendrich, R., (2001). Urban drainage control measures, in: Urban Drainage in Humid Tropics, C. E. M. Tucci

(ed.), Urban Drainage in Specific Climates, C. Maksimovic (ch. ed.), UNESCO Technical Documents in Hydrology, No. 40, Vol I, 125-154.

Stefan Ahlman (2006) Modelling of Substance Flows in Urban Drainage Systems Thesis For The Degree of Doctor of Philosophy Department of Civil and Environmental Engineering Division of Water Environment Technology Chalmers University of Technology Göteborg, Sweden

The Office of Code Enforcement Service, (2016) Denbe Addis edition 3 number 5 December 2016 Addis Ababa.

Tilahun Tessema, (2016) Study On Storm Water Drainage Situation In Addis Ababa Case Study For Jemo III Condominium Site Addis Ababa university institute of technology school of civil and environmental engineering

Tiza, Michael Toryila, Iorver, Vitalis Terpase & Iortyom, Enoch Terlumun (2016) The Effects of Poor Drainage System on Road Pavement: international journal for innovative research in multidisciplinary field issn – 2455-0620 Volume - 2, Issue - 8, Aug - 2016

UNCHS (1986) “Community participation and low-cost drainage – a training module”, United Nations Centre for Human Settlements, Nairobi, Kenya.

University of Nevada, Reno (2002) Nevada Milepost Nevada’s Technology Transfer Quarterly Vol. 12, No. 1

Victor K. Rono (2014) An Investigation Into The Adequacy of The Drainage System on Narok Mai Mahiu Road University of Nairobi School of The Built Environment Department of Real Estate and Construction Management Nairobi Kenya

Vijaya Manerikar & Sumeet Manerikar (2015) Cronbach's alpha A Peer Reviewed Research Journal aWEshkar Vol. XIX Issue 1 March 2015 WeSchool Mumbai, India.

Walsh, C. J. (2000). Urban impacts on the ecology of receiving waters: a framework for assessment, conservation and restoration. Hydrobiologia, 431(2-3), 107-114.

Waltenburg, Eric and McLauchlan,William, (2012). "Exploratory Data Analysis: a Primer for Undergraduates" Department of Political Science Faculty Publications. Paper 4.

Wilpert, B. (1991). Property, ownership, and participation: on the growing contradictions between legal and psychological concepts. In R. Russell, & V. Rus (Eds.), International handbook of participation in organizations: For the study of organizational democracy, co-operation, and self-management (Vol. 2, pp. 149–164). New York: Oxford University Press

World Bank, (2002b) Water, Sanitation and Hygiene at a Glance. Health, Nutrition and Population Sector Fact Sheet. The World Bank, Washington, DC.

World Bank (1992) Urban Policy and Economic Development. An Agenda for the 1990's. World Bank, Washington D.C.

World health organization (1991) Surface Water Drainage for Low-Income Communities Geneva printed in England.

Yamane, Taro. (1967). Statistics, an Introductory Analysis, 2nd ^{Ed}., New York: Harper and Row.

Appendices

(Questionnaire prepared to Addis Ababa city government executives & municipal service organs)

Addis Ababa University School of Graduate Studies Department of Public Administration and Development Management

Dear /sir /madam……

This study is being conducted for academic purpose which shall be submitted to the Addis Ababa University.

The aim of this study is to assess the Challenges of Sewerage and Drainages Maintenance Management System in Addis Ababa the Case of *Kirkos* Sub city.

I am requesting your participation in filling this questionnaire. Please be assured that all responses will remain confidential and all respondents will remain anonymous as the data will be presented and analyzed in groups.

There are no right or wrong answers for the questions and if you have any questions, do not hesitate to contact me with the following cell phone number 0958067071.

1. Name of your office or service organs sign /

Addis Ababa city road authority	
The Office of Code Enforcement Service control officers	
Addis Ababa city cleaning management agency cleaners	
Kirkos Sub city executives and district administration employees	

Question 2

Respondent Gender	Male	
	Female	
Age	15-19	
	20-24	
	25-29	
	30-34	
	35-Above	

Question 3

- Education attainment

☐ 1-8 grade /elementary school

☐ High school graduate

☐ Diploma

☐ Degree

☐ Post graduate

Q.4. which of the following best describes how often do you use *Kirkose* sub city Asphalt roads?

Frequently	
Two times a day	
4 up to 6 times a week	
2 up to 4 times a month	
I'm not user	
Do not know	

5. Opening cover, testing, cleaning and maintenance of drainage lines and drainage manholes, closing them in a reliable manner and making close monitoring?

require special skills	
Does not require special skill	
Do not know	

6. When Addis Ababa Roads Authority completes cleaning and maintenance works of drainage lines and drainage manholes on asphalt roads, what will it do with *Woreda* or utility offices of the *Woreda*?

Notify to the community and *Woreda* Offices in advance and upon completion of works	
Does not notify to the community and *Woreda* Offices in advance or upon completion of works either	
Sometimes it notifies and hands over upon completion	
Whether it notifies or hands over, there is no problem	
Don't know	

7. Executive bodies of *Kirkos* Sub-City and *Woreds* administrations know about asphalt road shaving problems with drainage lines and drainage manholes in the *Woreda?*

They know about the numbers and types of asphalts having problems	
They don't know about the numbers and types of asphalts having problems	
Don't know	

8. Let residents of the *Woreda* participate in drainage line and drainage manhole testing cleaning and maintenance activities to ensure their sense of their ownership as they are also vulnerable victims?

They can't because it requires special skills.	
They are not willing because of poor work culture	
They cause delayance in performance of works	
There is no one to motivate and coordinate community	
Don't know	

9. Persons who blocked drainage lines and drainage manholes by putting in solid waste and linked sewerage lines with drainage lines were arrested and penalized by Code Enforcement Officers because?

Negative acts	
They have no access to solid waste disposal and sewerage disposal services in time	
Of negligence and deliberate act	
Not to pay service fees	
Don't know	

10. Addis Ababa City Roads Authority blocked drainage lines and drainage manholes while cleaning these mainly because?

These are blocked by dust	
They are blocked by household solid waste	
Plastic water packaging bottles and plastic products	
Latrine sewerage deposits	
Don't know	

11. Drainage line manholes without cover in Sub-City are not properly closed, and in some cases the surface of the asphalt and cover are stucked because?

There is no appropriate maintenance	
There is no one to provide close monitoring and inspection on the road with a sense of ownership after maintenance	
There is a gap between users and owner of the road.	
Policy problem	
Don't know	

12. The task of control of violations on drainage lines and drainage manholes is very difficult for Code Enforcement Officers?

Violations are committed out of normal work hours of Code Enforcement Officers	
There is no sense of ownership on the part of residents	
There is lack of awareness about violations of regulations	
Residents are not cooperative as tippers	
Don't know	

13. Main findings during cleaning of main roads by *Kirkos* Sub-City Sanitation Administration are?

Dust collections	
Household solid waste	
Plastic water packaging materials	
Litters left around by illegal roadside traders	
Don't know	

14. Would you tell me the causes of problems with drainage lines and drainage manholes in asphalt roads in the sub-City?

……

……

……

……

……

……

……

(Questionnaire prepared to *Kirkos* sub city residents)

Addis Ababa University School of Graduate Studies Department of Public Administration and Development Management

Dear /sir /madam……

This study is being conducted for academic purpose which shall be submitted to the Addis Ababa University.

The aim of this study is to assess the Challenges of Sewerage and Drainages Maintenance Management System in Addis Ababa the Case of *Kirkos* Sub city.

I am requesting your participation in filling this questionnaire. Please be assured that all responses will remain confidential and all respondents will remain anonymous as the data will be presented and analyzed in groups.

There are no right or wrong answers for the questions and if you have any questions, do not hesitate to contact me with the following cell phone number 0958067071.

Question 1 Location

Respondents location *Kirkos* sub city district	/	Respondents location *Kirkos* sub city district	/
District 1		District 7	
District 3		District 8	
District 4		District 9	
District 5		District 10	
District 6		Other District	

Question 2

Respondent Gender	Male	
	Female	
Age	15-19	
	20-24	
	25-29	
	30-34	
	35-Above	

3. Education attainment

- ☐ 1-8 grade /elementary school
- ☐ High school graduate
- ☐ Diploma
- ☐ Degree
- ☐ Post graduate

4. Which of the following best describes how often do you use *Kirkose* sub city Asphalt roads?

Frequently	
Two times a day	
4 up to 6 times a week	
2 up to 4 times a month	
I m not user	
Do not know	

5. Opening cover, testing, cleaning and maintenance of drainage lines and drainage manholes, closing them in a reliable manner and making close monitoring?

Requires special skill	
Does not require special skill	
Don't know	

6. The community has been performing either with their money or material to resolve problems of the manholes that having rain stagnant water, manholes do not cover properly which disturb movement of the community?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

7. The community has immediately resolve problems when they observe poor drainage mark before sustaining gross damage?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

8. After rain, the community has exchanging information with concerned organs pertaining to the proper function of the drainage manhole after observing the same?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

9. The community has participated in providing information during maintenance activities and participated in monitoring activities after maintenance conducted?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

10. The community has know period of drainage system maintenance in the surrounding, have maintained adequate information that signed by heads thereby made to clean and monitoring as per the program?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

11. The road and drainage work needs higher cost. Outside fund paid for the road by the community, has been closely monitoring over drainage system in voluntary?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

12. Making that community in assessing and evaluating executive organs that assigned by the administration towards affairs of drainage periodically?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

13. The problems that occur during maintenance period wage, cash and material have resolved along with the community and support?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

14. Beyond decreasing cost for maintenance since the *Woreda* and community have responsibly performed that upgrade awareness of the community?

Strongly Agree.	
Agree	
Undecided	
Disagree	
Strongly Disagree	

15. Where solid waste is not collected in time, it might cause health hazard; thus it should be disposed away from residential areas?

Absolutely agree	
Agree	
Somehow agree	
Disagree	
Don't know	

16. In your *Woreda* there is a community Committee that is in charge of testing, cleaning and maintenance of drainage lines and manholes by opening their covers and closing covers and providing close monitoring in this respect?

Yes	
No	
Don't know	

17. The practice of disposing solid waste in a concealed hole located in a place that suits easy visibility?

Absolutely accepted	
Accepted	
May be somehow accepted or not accepted	
Disagree	
Don't know	

18. The use of rainwater is that it washes away all waste?

Absolutely agree	
Agree	
Somehow agree	

19. Sewerage waste, rain water waste and solid waste are all similar?

Agree	
Disagree	
Don't Know	

20. Rainwater flow on pedestrian and asphalt roads?

Because of high rainfall	
Because drainage lines are blocked	
Because drainage manholes do not allow rainwater to flow in	
Don't know	

21. Drainage lines and roads are owned by government?

Yes they are	
The owner is the beneficiary people	
Don't know	

22. Do you have detailed information on the types of penalties punishable on violation of codes?

Yes I do absolutely	
I know	
I don't know exactly what is punishable and what is not	
Don't know anything at all	
Un decided	

23. Would you please tell me the cause of the problem with drainage manholes of asphalt roads in the Sub- City?

……
……
……
……
……
……
……
……..

Appendix

Location of Poor drainage roads in *Kirkos* sub city in *Woreda* / district level. (Addis Ababa City Road Authority, Drainage grade 2016)

No	Road starting and ending point	Road found
1	From *Hilton* Hotel to *Kazanchiz meberat*	*Kirkos* sub city *woreda* 8
2	From *Anbasader* theater to *Zewditu*	*Kirkos* sub city *woreda* 7
3	From *Zewditu* to *Sheraton* Hotel	*Kirkos* sub city *woreda* 7
4	From *Filwha* hotel to *Zewditu* Hospital	*Kirkos* sub city *woreda* 7
5	From *Zeditu* Hospital through *Horma garage* to Post Office	*Kirkos* sub city woreda 7
6	From *Yordanos* hotel to *Kazanchiz meberat*	*Kirkos* sub city *woreda* 8
7	From *Kazanchiz Menaheria* hotel to Junction	*Kirkos* sub city *woreda* 8
8	From *Gibi Gebriel* junction to *Kazanchiz 6th Police Station*	*Kirkos* sub city *woreda* 8
9	From 6th Police Station to 93.1 Road	*Kirkos* sub city *woreda* 8
10	From total to *Adewa (Sigenal)*	*Kirkos* sub city *woreda* 8
11	From *Kazanchiz* Total to S/t Urael church	*Kirkos* sub city *woreda* 8
12	From *Kazanchiz* to *Bambis*	*Kirkos* sub city *woreda* 8
13	From *Meskel* Sq to *Gotera* inter-change	*Kirkos* sub city *woreda* 9(4)
14	From *Gotera* inter change to *Wolo Sefer*	*Kirkos* sub city *woreda* 3
15	From *Zerihun* Building through *Atlas* hotel to *Worbec* building	*Kirkos* sub city *woreda* 1
16	From S/t Urael church to *Bole brass* clinic	*Kirkos* sub city *woreda* 1
17	From *Gofa Mazoria* to *Telecomunication* Building *Kikos* Junction	*Kirkos* sub city *woreda* 4
18	From *Bulgaria Mazoria* to Junction	*Kirkos* sub city *woreda* 4
19	From *Mexico* to *Bulgaria mazoria*	*Kirkos* sub city *woreda* 10
20	From *Bulgaria Mazoria* to *Kera*	*Kirkos* sub city *woreda* 4
21	From *Tinbajo monopol* through African union hall to *Bulgaria Mazoria*	*Kirkos* sub city *woreda* 5
22	From *Meskel* Sq to *Megenana* RA	*Kirkos* sub city *woreda* 1
23	From T junction (back of *gumuruk)* to 4th *battalion* main gate	*Kirkos* sub city woreda 10
24	From Popurale to *kirkos* church to *meskerem mazoria*	*Kirkos* sub city woreda 6
25	From *tinbaJo monopol* through AU to *genet* hotel	*Kirkos* sub city woreda 6
26	From Road 186 Asp Jun To *salvatore di vita* & Family PLC	*Kirkos* sub city woreda 4
27	From *Dan Techno office* through no 108 to *Bole* Printing Junction	*Kirkos* sub city woreda 9(2)

Annex 1

The photo of the researcher has captured during Dec 2016 at *Kirkos* Sub City *Woreda* 9 Special Place *meskerm mazoria* riche area for evidence.

The photo of the researcher has captured during Dec 2016 at *Kirkos* Sub City *Woreda* 7 Special Place stadium area for evidence.

Annex 2




The photo of the researcher has captured during April 2016 at *Kirkos* Sub City *Woreda* 10 Special Place at the back side of *Legehare germen gibi* for evidence.


Annex 3

The photo of the researcher has captured during April 2016 at *Kirkos* Sub City

Annex 4

Drainage maintenance activity (Addis Ababa City Road Authority)